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Water Quality Of The Peace River In Alberta

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Peace River looking downstream towards Fort Vermilion

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WATER QUALITY OF THE PEACE RIVER IN ALBERTA

Prepared by:

R.D. Shaw, Ph.D.
Shaw Environmental Consulting

L.R. Noton, M.Sc.
A.M. Anderson, Ph.D.
Environmental Quality Monitoring Branch
Environmental Assessment Division
Environmental Protection Services

G.W. Guenther
Hydrology Branch
Technical Services Division
Water Resources Management Services

Alberta Environment

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Environmental Quality Monitoring Branch
Environmental Assessment Division
Environmental Protection Services
Alberta Environment

Edmonton, Alberta

OVERVIEW

In 1988, Alberta Environment began an extensive water quality study of the Peace River within Alberta. The Peace River, which originates in British Columbia, drains much of northern Alberta and conveys the greatest volume of water of any river in the province. The Peace River drainage basin is sparsely populated and largely undeveloped. Agriculture and forestry are the main economic activities. The primary sources of effluent to the river and its tributaries within Alberta include the Procter and Gamble pulp mill at Grande Prairie, which discharges to the Wapiti River, and five continuously discharged effluents from municipal sewage treatment systems. There is also one abandoned oil well that discharges water to the Peace River.

Objectives

There were five main objectives for the water quality study that was carried out between May 1988 and March 1989:

1. To characterize water quality patterns over several seasons and years from the B.C.-Alberta border to the river's confluence with the Slave River.
2. To identify factors that affect water quality in the mainstem (the Peace River proper).
3. To assess mixing of the Smoky and Peace rivers.
4. To describe the invertebrate animal communities (zoobenthos) that inhabit the bed of the Peace River.
5. To compare water quality in the river with Alberta Surface Water Quality Objectives (ASWQO) and the Canadian Water Quality Guidelines (CWQG).

Study Design

Samples were collected monthly during May through September 1988 and once in December 1988 and February 1989 from ten sites along the Peace River and from ten tributary rivers. Locations were chosen to provide semi-uniform coverage along the river. The six largest effluents were also sampled each trip, and additional samples were collected to provide information on mixing between the Smoky and Peace rivers. A comprehensive list of physical, chemical and biological constituents were analyzed, including trace organic compounds in some samples. Invertebrate animals were sampled in July, September and October 1988.

In addition to data collected during the study, information from other sampling programs was used to determine long-term trends in water quality in the Peace River. The most complete record is from Environment Canada's sampling station at Dunvegan.

Results of the Study

Long-term Trends. Based on data from Dunvegan, the water quality of the Peace River has changed slightly since 1977. Levels of fecal streptococci bacteria and one metal (boron) have increased, while levels of eight other substances or characteristics have decreased. Levels of dissolved oxygen have increased slightly. These long-term changes may relate to changes in the water quality of Williston Reservoir on the Peace River in British Columbia.

Water Quality Characteristics of the Peace River. Three relatively homogeneous sections, or reaches, of the river were identified. The upstream reach, which extends from the B.C.-Alberta border to the Smoky River, has few tributaries and no effluent inputs. Compared to other sections of the river, this reach had relatively clear water and high dissolved oxygen content, with fairly high amounts of algae (as estimated by measuring chlorophyll a) attached to rocks. Concentrations of metals, nutrients, organic matter, bacteria and salts were low.

An intermediate reach extends from the Smoky River to near Fort Vermilion. Concentrations of most constituents increased gradually along this reach as a result of tributary inputs, particularly from the Smoky River. Smoky River water does not mix fully with water in the Peace River for at least 100 km downstream. Increases in sodium and chloride along this reach of the Peace River were also partly a result of discharge from the Procter and Gamble pulp mill and the abandoned Peace River Oils flowing well. Numbers of bacteria were higher as a result of inflow from the Smoky River and possibly also as a result of municipal sewage effluent from the Town of Peace River.

The downstream reach extends from Fort Vermilion to the mouth of the Peace River. Water quality in this section was partly influenced by natural tributary inflows, but more strongly by a change from gravel to sand and silt in the channel bed and along the river bank. As a result, levels of suspended solids were high, and substances that are naturally associated with clay particles, such as metals, were also highest in this reach.

The composition of the community of invertebrate animals living on the river bottom also reflected the three river reaches. The upstream reach contained high numbers and a wide variety of animals. In the intermediate reach, there were lower total numbers, but a greater variety of species (high diversity). In the downstream reach, both total numbers and diversity were low, because the sand and silt bottom is less hospitable than the gravel or cobble bottom in the upstream reaches.

Compliance with Water Quality Guidelines. Water quality in the Peace River does not always meet the Alberta Surface Water Quality Objectives or the Canadian Water Quality Guidelines for the protection of freshwater aquatic life. Several metals, nutrients and phenolics exceeded guideline levels at times. These were generally associated with increases in suspended solids, and are therefore a result of natural processes rather than from human activity in the watershed.

Conclusions

In many respects, the water quality of the Peace River is unique compared to other major rivers in Alberta. Concentrations of dissolved substances in the Peace River tend to be lower and more constant over time and space, while concentrations of suspended particles - silt and organic matter - tend to be higher than in other rivers. Effluent discharges have little effect on the Peace River. Its water quality reflects the high quality water originating from its headwaters, the river's large size relative to tributary and effluent inputs, and natural scouring processes along its length.

ACKOWLEDGEMENTS

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Electronic data processing was carried out by D. Asquin, M. Soetart, and R. Tchir of EQMB. Figures were prepared by Technical Services Division under the supervision of T. Zenith. Information on river hydrology was provided by G. Fonstad of Technical Services Division. Technical support was provided by L. McIntyre. A draft of this report was reviewed by D. Trew, D. Spink, D. Smillie, G. Fonstad, T. Tarpey, and M.S. McClure.

ABBREVIATIONS

d/s	downstream
u/s	upstream
AEC	Alberta Environmental Centre
AECA	Alberta Environment Conservation Authority
ASWQO	Alberta Surface Water Quality Objectives
BOD	Biochemical Oxygen Demand
CA	Cluster analysis
CCREM	Canadian Council of Resource and Environment Ministers
CWQG	Canadian Water Quality Guidelines
DN	Dissolved nitrogen
DO	Dissolved oxygen
DOC	Dissolved organic carbon
EQMB	Environmental Quality Monitoring Branch
NTU	Nephelometric Turbidity Units
O&G	Oil and grease
P&G	Procter and Gamble pulp mill
PCA	Principal component analysis
PN	Particulate nitrogen
POC	Particulate organic carbon
PRRPC	Peace River Regional Planning Commission
RCU	Relative colour units
SPC	Standard Plate Count
SS	Suspended solids
STP	Sewage treatment plant
T&L	Tannin and lignin
TDP	Total dissolved phosphorus
TDS	Total dissolved solids
TKN	Total Kjeldahl nitrogen
TN	Total nitrogen
TOC	Total organic carbon
TP	Total phosphorus
USEPA	United States Environmental Protection Agency

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1. INTRODUCTION

The Peace River conveys the greatest volume of water of any river in Alberta and its drainage basin covers one-third of the province. The Peace River originates in north-eastern British Columbia, flows through Williston Reservoir and the Bennett Dam and enters Alberta west of the Town of Peace River. The river flows north-easterly across northern Alberta and drains into the Slave River, north of Ft. Chipewyan (Fig. 1).

The Peace River Basin is a major sub-basin of the Mackenzie River; consequently, aspects of the water quality of the Peace River have been investigated in some studies that have focussed on the broader Mackenzie River Basin. For example, the regional variation in chloride content of Mackenzie Basin rivers has been evaluated (Hitchon et al. 1969). The geochemistry of the Peace River and some of its tributaries was examined based on a one-time sampling of the Mackenzie River system in 1969 (Dewis et al. 1972, Reeder et al. 1972). Spatial and temporal variation of water quality in the Peace River and one of its tributaries (Smoky River) was assessed as part of an evaluation of rivers and lakes in the Mackenzie River Basin (Blachford et al. 1985).

The water quality of rivers within the Peace River Basin has also been the primary focus of a number of previous studies. The water quality of the Peace River in British Columbia has been assessed by the B.C. Ministry of the Environment (Butcher 1985, 1987) and Kathman and Cross (1989). An initial overview of water quality conditions in the Peace River Basin in Alberta has been prepared by IEC Beak Consultants Ltd. (1985) and less detailed reports are also available (e.g., Reeder 1971, PRRPC 1977). The impact of effluent from the Procter and Gamble pulp mill on the water quality of the Wapiti and Smoky rivers has been assessed (Noton et al. 1989), as has the impact of pulp mills on the Peace River mainstem (Shaw and Noton 1989). In addition, the effect of

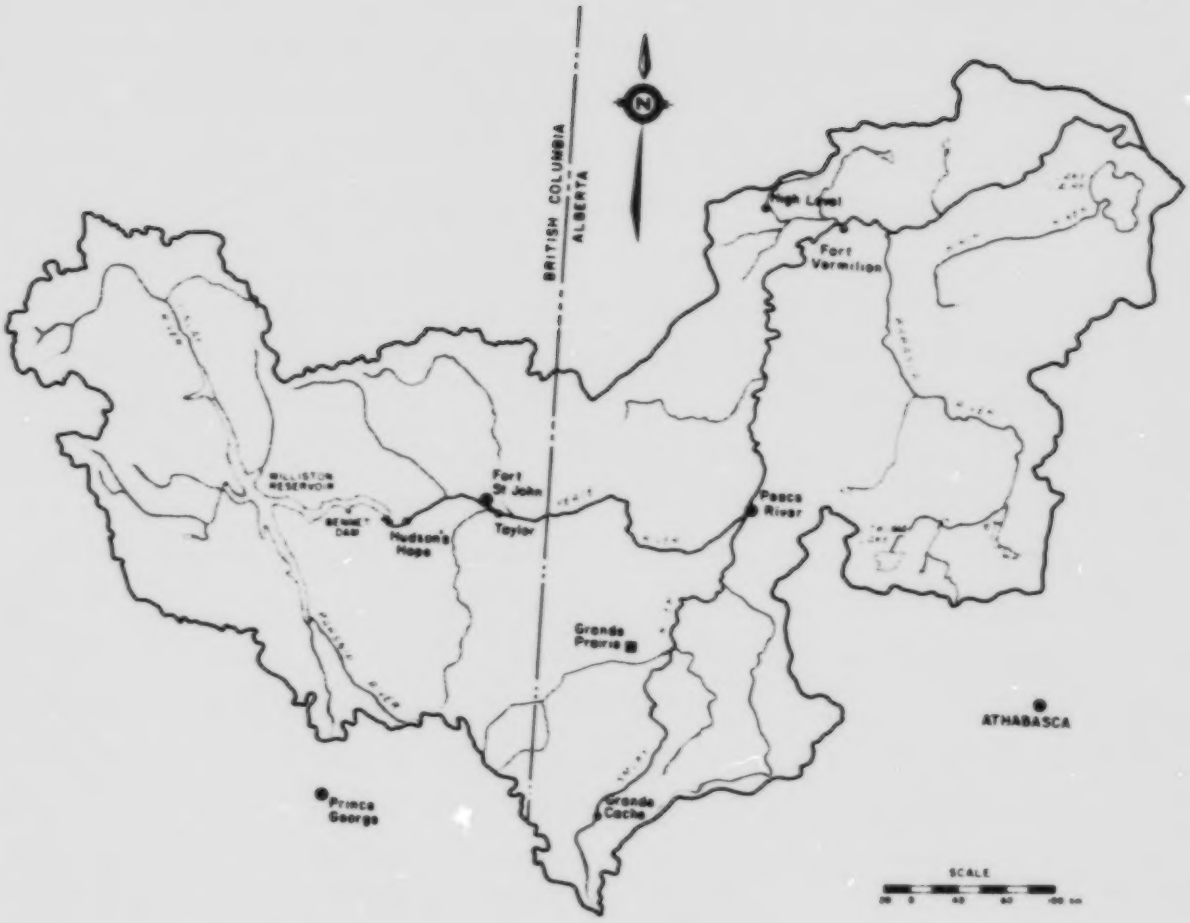

Fig. 1. Peace River Basin.

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the abandoned, Peace River Oils No. 1 flowing well on mainstem water quality has recently been evaluated (Alberta Environment 1989).

The general purpose of this report is to provide a comprehensive description of water quality conditions in the Peace River in Alberta. Specific objectives include:

- presentation of water quality data obtained during a one-year field program, which was carried out in 1988-1989 by Alberta Environment to augment the existing database,
- evaluation of seasonal, long-term, and longitudinal trends in water quality of the Peace River mainstem,
- assessment of factors affecting the water quality of the mainstem, including point (tributaries and effluents) and non-point (groundwater, diffuse runoff) sources,
- comparison of water quality in the mainstem with published objectives and guidelines,
- description of zoobenthic communities in the Peace River, based on data collected by Alberta Environment in 1987 and 1988.
- assessment of mixing of the Peace and Smoky rivers, and
- identification of river reaches based on multivariate analysis of the 1988-89 survey data.

Pertinent information on basin characteristics and hydrology is included to aid in the interpretation of water quality patterns, and interactions between physical, chemical, and biological components of the river system are discussed.

2. METHODS

2.1 GENERAL

Prior to 1988, most water samples in the Peace River system had been collected from mainstem sites at Dunvegan, the Town of Peace River, Ft. Vermilion, and Peace Point, and from a site on the Smoky River at Watino. The Watino site is presently sampled as part of Alberta Environment's long-term monitoring network. The most complete record is from Environment Canada's station at Dunvegan (sampled intermittently: 1969-1977, monthly: 1978 to present). A number of other sites along the mainstem and tributaries were also sampled intermittently in the 1960s and 1970s by Environment Canada. Most of these data are stored in Alberta Environment's NAQUADAT database. Since 1984, the river has been monitored biweekly at the B.C. border near Alces River, B.C. by Environment Canada and the British Columbia Ministry of the Environment. Historical station sites and NAQUADAT codes are listed in Appendix I.

In 1988, the Environmental Quality Monitoring Branch (EQMB), Alberta Environment, initiated an extensive field study to collect baseline data to document existing water quality conditions of the Peace River system in Alberta. Water samples were collected monthly from May to September 1988, and in December 1988 and February-March 1989 from 10 mainstem sites, 10 tributaries, and 6 effluents (Table 1; Fig. 2). An additional tributary (Mikkwa River) was sampled during four of the surveys. Mainstem sites were situated at key locations and to provide semi-uniform coverage along the Peace River. Tributaries were selected to include those with the greatest flows and to cover the range of physiographic zones in the Peace River Basin. The effluents sampled were the major sources of wastewater of potential impact on river water quality. For each survey, a comprehensive group of physical, chemical, and biological constituents were analyzed (Appendix II). Water samples collected during May, August, and October 1988, and February-March 1989

Table 1. Water quality sampling sites for synoptic surveys, 1988-1989.

Description	NAQUADAT Station Code	River km[1]
PR near border-c	00BC07FD1050	0
Pouce Coupe R.-c	00AL07FD0500	6
PR near Dunvegan-cmp	00AL07FD1600	137
PR near Dunvegan-c	00AL07FD1525	137
PR u/s Smoky R.-cmp	00AL07FD4600	213
PR u/s Smoky R.-c	00AL07FD4575	213
P.R.Corr.Inst. sewage	21AL07FD1000	218
Smoky R.-cmp	00AL07GJ4995	223
Grande Prairie sewage[2]	21AL07GE1000	-
P&G Effluent-grab[2]	20AL07GE8000	-
P&G Effluent-cmp[2]	20AL07GE8001	-
Town of Peace River sewage	21AL07HA1000	234
Peace River Oils	00AL07HA2400	253
PR d/s proposed pulp mill-l[3]	00AL07HA2500	253
PR d/s proposed pulp mill-lc[3]	00AL07HA2500	253
PR d/s proposed pulp mill-c[3]	00AL07HA2500	253
PR d/s proposed pulp mill-rc[3]	00AL07HA2500	253
PR d/s proposed pulp mill-r[3]	00AL07HA2500	253
PR u/s Whitemud R.-cmp	00AL07HA2850	286
PR u/s Whitemud R.-l[3]	00AL07HA2800	286
PR u/s Whitemud R.-lc[3]	00AL07HA2810	286
PR u/s Whitemud R.-c[3]	00AL07HA2820	286
PR u/s Whitemud R.-rc[3]	00AL07HA2830	286
PR u/s Whitemud R.-r[3]	00AL07HA2840	286
Whitemud R.-cmp	00AL07HA3000	288
Cadotte R.-cmp	00AL07HB1000	300
PR east of Manning-l[3]	00AL07HC1000	327
PR east of Manning-lc[3]	00AL07HC1010	327
PR east of Manning-c[3]	00AL07HC1020	327
PR east of Manning-rc[3]	00AL07HC1030	327
PR east of Manning-r[3]	00AL07HC1040	327
PR u/s Notikewin R.-c	00AL07HC1200	380
Notikewin R.-cmp	00AL07HC1400	396
PR near Carcajou-c	00AL07HD1030	482
Wolverine R.-c	00AL07HE1000	485
Keg R.-l	00AL07HF1300	513
PR near La Crete-c	00AL07HF1530	571
PR near Ft. Vermilion-c	00AL07HF1720	655
Ft. Vermilion sewage	21AL07HF1000	665
Boyer R.-r	00AL07JF1000	660
Wabasca R.-c	00AL07JD1000	705
Mikkwa R.-c	00AL07JE1000	741
Wentzel R.-l	00AL07KA1500	764
Wentzel R.-l	00AL07KA1000	764
PR u/s Wood Buffalo-c	00AL07KA2000	800
PR near Peace Point-c	00AL07KC1000	957

[1]Measured from 1:50,000 scale maps.
[2]Effluent discharges to a tributary of the Smoky River (see Table 5).
[3]Sampled as part of Smoky-Notikewin reach study.
PR - Peace River mainstem; P&G - Procter and Gamble kraft pulp mill
u/s - upstream; d/s - downstream; cmp - composite sample from left and right banks; grab samples collected from: l -left bank, lc -left centre, c - centre, rc - right centre, r -right bank.

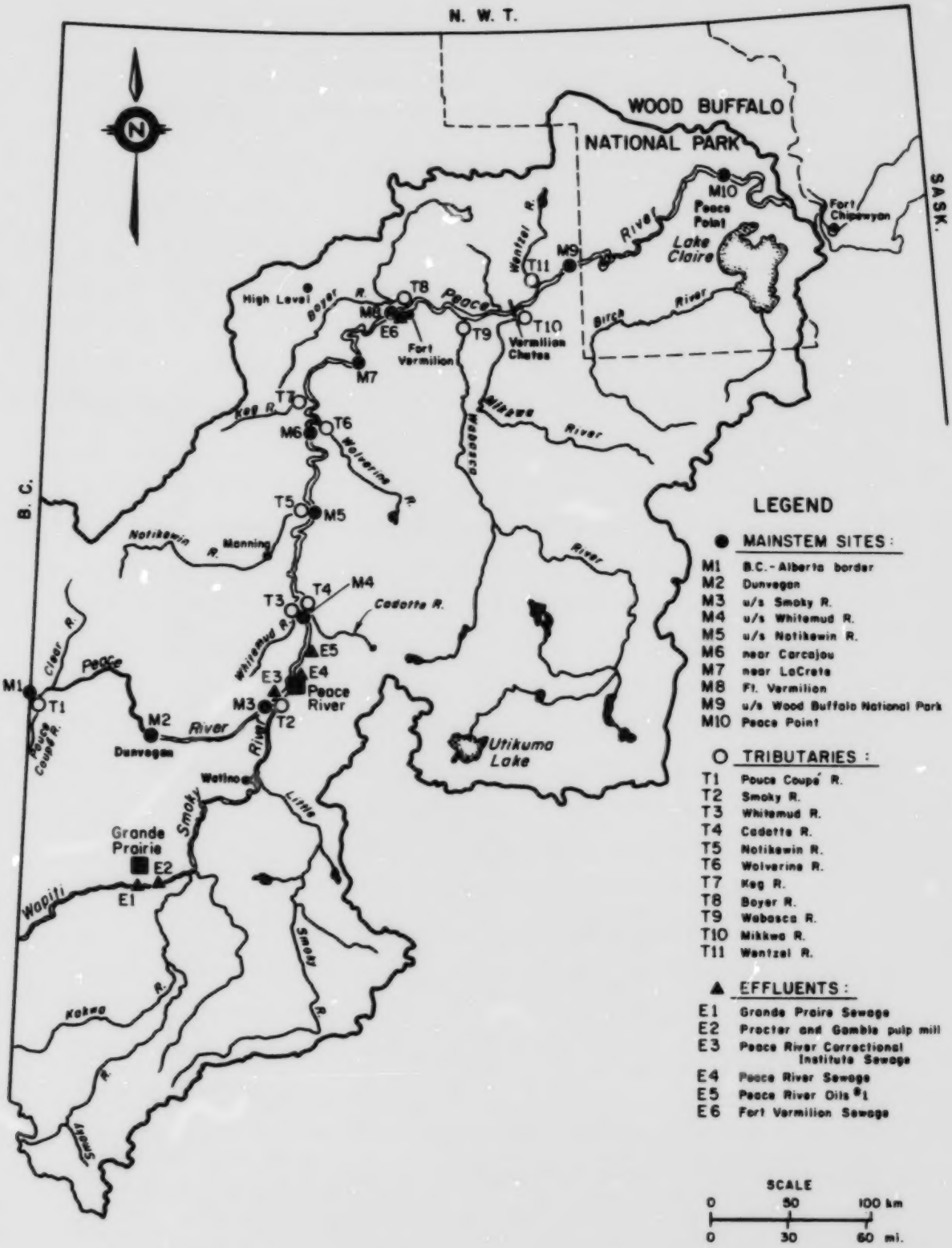

Fig. 2. Sampling sites in the Peace River system, 1988-89.

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were also analyzed for trace organic compounds (Appendix II).

In addition to the sites described above, water samples were collected from three mainstem sites in the reach between the Smoky and Notikewin rivers in May and October, 1988, and February 1989 (Table 1; Fig. 3). At each site, five samples were collected from a transect across the river to provide information on mixing between the Smoky and Peace rivers and to define a baseline for assessing the potential impact on river water quality of effluent from the Daishowa pulp mill, which is currently under construction. These samples were analyzed for a limited number of variables (Appendix XI).

Benthic invertebrates were sampled in September 1988 at the mainstem sites only. Additional mainstem sites were sampled near the B.C.-Alberta border in May and September 1987 and July and September-October 1988, and also in the reach between the Smoky and Notikewin rivers in July and October 1988 (Table 2; Fig. 3).

Further details of the field and laboratory methods for the 1988-1989 synoptic surveys are included in Appendix III and aspects of quality assurance of these data are in Appendix IV.

2.2 DATA TREATMENT

2.2.1 Water Quality

The most complete, long-term, water quality data set for the Peace River is from Dunvegan. Data collected monthly from 1978 to 1988 were tested for flow-dependency, seasonality, serial correlation, and long-term trends. It is well known that concentrations of some variables are related to river discharge (Harned et al. 1981, Hirsch et al. 1982, Smith et al. 1982). For flow-dependent variables, the detection of seasonal and long-term trends may be obscured by changes in streamflow. In such cases, a residual analysis technique was used to determine flow-adjusted concentrations. First, for each variable, a best-fit

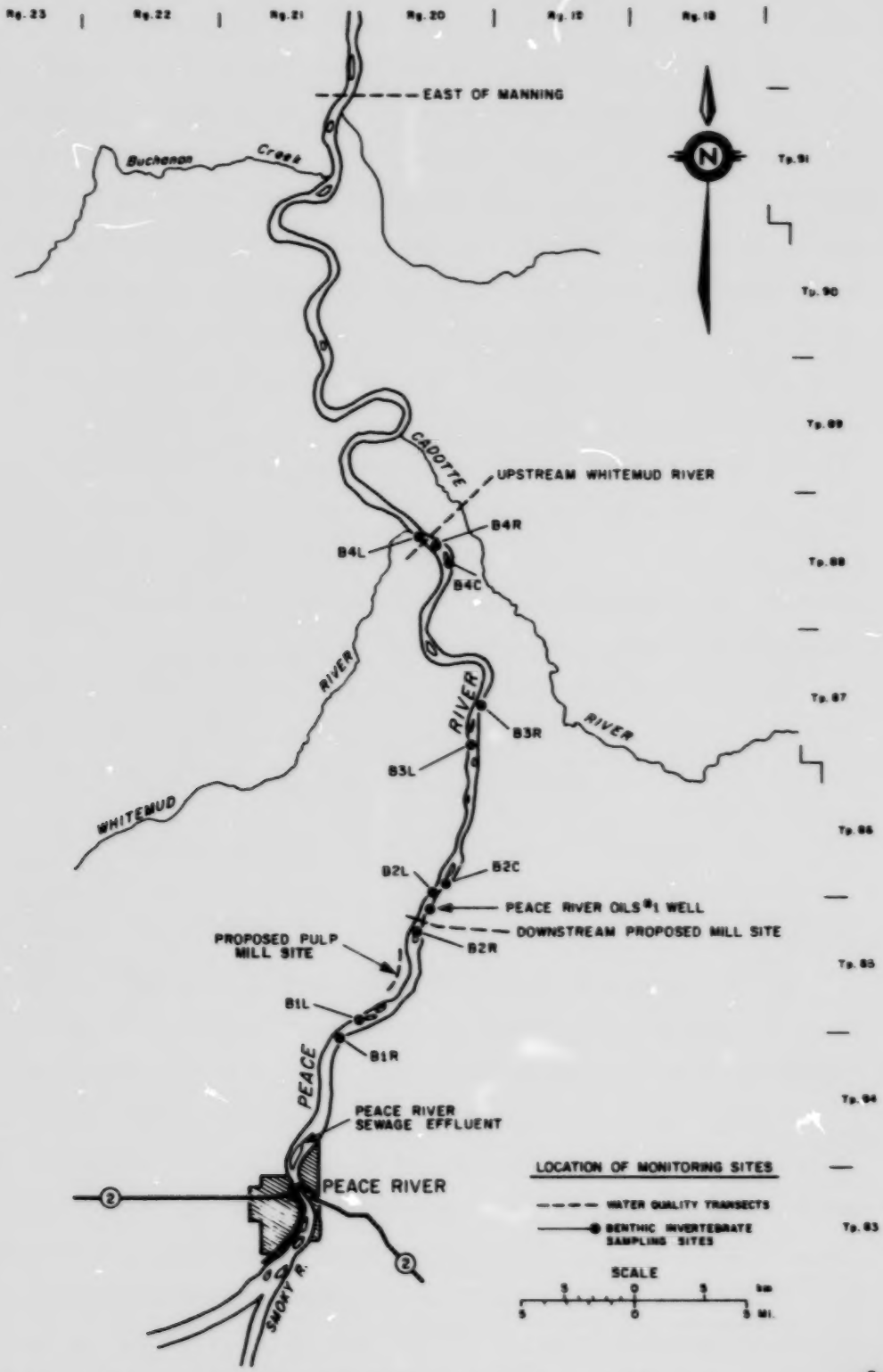

Fig. 3. Water quality and benthic invertebrate sampling sites for reach study, 1988-89.

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Table 2. Peace River zoobenthic sampling sites, location codes (in brackets), and dates.

NAQUADAT Code	Site Description	Sampling Date(s)
00BC07FD1100	B.C.-Alberta border-r	May and Sept. 1987, July and Oct. 1988
00BC07FD1000	B.C.-Alberta border-l	May and Sept. 1987, July and Oct. 1988
00AL07FD1000	4.2 km u/s Clear River-c	Sept. 1987 and Sept. 1988
00AL07FD1050	0.25 km u/s Clear River-l	May and Sept. 1987, July and Sept. 1988
00AL07FD1100	0.25 km u/s Clear River-r	May and Sept. 1987, July and Sept. 1988
00AL07FD1500	Dunvegan-l	Sept. 1988
00AL07FD4500	Above Smoky River	Oct. 1988
00AL07HA2100	4 km u/s Daishowa (B1R)	July and Oct. 1988
00AL07HA2150	3 km u/s Daishowa (B1L)	July and Oct. 1988
00AL07HA2200	2 km d/s Daishowa (B2R)	July and Oct. 1988
00AL07HA2600	5 km d/s Daishowa (B2L)	July and Oct. 1988
00AL07HA2620	7 km d/s Daishowa (B2C)	July and Oct. 1988
00AL07HA2640	17 km d/s Daishowa (B3L)	July and Oct. 1988
00AL07HA2660	20 km d/s Daishowa (B3R)	July and Oct. 1988
00AL07HA2680	32 km d/s Daishowa (B4R)	July and Oct. 1988
00AL07HA2700	33 km d/s Daishowa (B4C)	July and Oct. 1988
00AL07HA2800	35 km d/s Daishowa (B4L)	July and Oct. 1988
00AL07HC1200	Above Notikewin River	Sept. 1988
00AL07HD1030	Near Carcajou -c	Sept. 1988
00AL07HF1530	Near La Crete	Sept. 1988
00AL07HF1700	At Fort Vermilion	Sept. 1988
00AL07KA2000	Above Wood Buffalo N. P.	Sept. 1988
00AL07KC1000	Near Peace Point-c	Sept. 1988

u/s - upstream, d/s - downstream, c - centre, l - left bank, r - right bank. Location codes are for reach samples only, Fig. 3.

regression of concentration against discharge was calculated. If the slope of the regression was significantly different from 0 (at $P<0.05$) and the regression model explained more than 10 % of the variance in the data (i.e., $r^2>0.10$), then the variable was considered to be flow-dependent. For flow-dependent variables, the regression model was used to provide expected concentration for every flow, and the flow-adjusted concentration is the actual concentration minus the expected concentration (i.e., residual). For flow-dependent variables, both the actual and flow-adjusted concentrations were tested for long-term trends as outlined below.

Most parametric and non-parametric statistical tests for long-term trends require data that are independently distributed. However, water quality data are often time dependent - either because of seasonality, serial correlation, or both (Montgomery and Reckhow 1984). Seasonality implies that the value of a variable exhibits fluctuations based on the time of the year. Seasonality increases the variance of the data, which decreases the power of many statistical tests for long-term trends. Thus, if seasonality is present, the data should be deseasonalized before testing for trends, or statistical tests that account for seasonality should be used. Seasonal trends in the flow-dependent constituents were assessed graphically by inspection of box and whisker plots of actual and flow-adjusted concentrations on month. Box and whisker plots show the median, minimum and maximum values (whiskers) and the interquartile values (box) and provide an indication of seasonal change in the constituent concentrations. For flow-dependent variables, a comparison of the seasonal plots of actual and flow-adjusted concentrations may reveal seasonal effects due to factors other than discharge. In addition, seasonality was tested statistically with the Kruskal-Wallis test (Loftis et al. 1989).

Serial correlation arises from the fact that the value of a data point is dependent, to some degree, upon the value of previous data

points (after seasonality and trend have been removed). Serial correlation was assessed with the use of a correlogram (Loftis et al. 1989). If serial correlation was present, then quarterly data rather than monthly data were used to test for long-term trends.

Long-term trends were assessed graphically by inspection of time-series plots and statistically with either the Seasonal Kendall test (if seasonality was significant) or the Kendall test (if seasonality was not significant) (Hirsch et al. 1982; Berryman et al. 1988). The null hypothesis for the Kendall tests is that the constituent concentrations (actual or flow-adjusted) are independent of time. These are non-parametric tests and are not dependent on normally distributed data. In addition, missing values or values reported below the analytical detection limit (i.e., censored data) present no problems for the Kendall tests.

All analyses were carried out on an IBM-AT personal computer with a LOTUS 123 program, which was developed to test for flow-dependency and compute flow-adjusted concentrations, and with WQSTAT II, a water quality statistics program to assess seasonality, serial correlation and long-term trends (Loftis et al. 1989).

Spatial trends in surface water quality in the Peace River Basin were assessed graphically and statistically, based on data collected during the 1988-1989 synoptic surveys. Plots of mean, minimum, and maximum values on river kilometre are presented for most variables. For most plots, arithmetic means were used as an estimate of central tendency. Since most sampling occurred during the open-water season the means will be biased towards that season and may not accurately represent average annual conditions.

Cluster analysis (CA) and principal component analysis (PCA) were used to statistically evaluate spatial patterns in surface water quality in the Peace River Basin. CA and PCA are multivariate techniques that

provide a means of grouping sites according to their water quality characteristics. These analyses were performed on a subset of data collected from all mainstem sites and tributaries that were sampled during three of the 1988-1989 synoptic surveys - June and October 1988 and February-March 1989. These surveys corresponded to conditions of peak open-water flow, low open-water flow, and ice-covered flow, respectively. The variables analyzed consisted of important chemical and biological constituents. Highly correlated variables were excluded as were those with a large number of censored data. It was assumed that biological indicators (bacterial counts, chlorophyll-a) and variables related to particulate matter (suspended solids) were log-normally distributed (Hirsch and Slack 1984); thus, a log-transformation was applied to normalize those data. The multivariate analysis was performed with CLUSTAN (Wishart 1978) on an AMDAHL 5870 computer.

Mass transport of constituents was evaluated at selected sites along the mainstem and at all tributaries and effluents that were sampled in 1988-1989 to (1) identify the major point-source loads to the river, and (2) determine whether loading from the tributaries and/or effluents could account for the observed longitudinal changes in water quality of the Peace River mainstem. Mass loads were calculated as the average concentration times the average discharge, as measured during the synoptic surveys. Thus, as indicated above, the values are biased towards the open-water season. Surveys were not evaluated individually because the sampling progression along the mainstem did not match the river's time of travel.

2.2.2 Zoobenthos

The zoobenthic data analysis concentrated on the identification of spatial trends with respect to taxonomic composition and abundance. Cluster and principal components analyses were performed on log(x+1)-transformed benthic invertebrate data from the fall 1988 synoptic

surveys to identify groups of sites with similar zoobenthic associations. Both CA and PCA provide means of comparing samples using all information contained in these samples and, therefore, provide better overall comparisons among sites than summary variables such as total numbers, number of taxa, and numbers within major groups. Taxa of erratic occurrence and low numeric density were excluded from the CA and PCA. The SPSSx statistical package (SPSS Inc. 1983) was used for data file manipulation and the multivariate analyses were performed using CLUSTAN (Wishart 1978) on an Amdahl 5870 computer.

2.3 WATER QUALITY OBJECTIVES AND GUIDELINES

River water quality was assessed by comparing observed values for selected constituents with the Alberta Surface Water Quality Objectives (ASWQO; Alberta Environment 1977) and with the Canadian Water Quality Guidelines for the protection of freshwater aquatic life (CWQG; CCREM 1987). If there was no CWQG for freshwater aquatic life, then the most stringent alternative CWQG guideline that pertains to raw water was used. River water quality was not compared to drinking water guidelines because treatment technology is available to produce drinking water from source water of almost any quality (CCREM 1987).

Values outside the limits identified in the ASWQO or CWQG were described as non-compliant. However, this does not imply that enforcement action is required since the limits are not legal standards. In addition, two important conditions that govern the application of the ASWQO should be kept in mind: (1) the Objectives "apply to surface water except in areas of close proximity to outfalls", and (2) the Objectives do not apply "where the natural water quality of a lake or river does not meet some of the suggested limits" (Alberta Environment 1977).

3. BASIN CHARACTERISTICS

3.1 CLIMATE, GEOLOGY, AND ECOREGIONS

The climate in the Peace River Basin is continental and is characterized by short winter days and long summer days. The mean winter temperature over the basin is approximately -15.5 oC, although in the northern-most portion of the basin the mean temperature is several degrees colder (Strong and Leggat 1981). The coldest temperatures occur during the last half of January. The mean summer temperature is 12 oC; in the north, the mean temperatures are a couple of degrees colder. The warmest temperatures occur in mid-July. Mean annual areal evapotranspiration varies from 297 mm at Ft. Vermilion to 398 mm at Beaverlodge (Bothe and Ames 1984). The region has a relatively dry climate. Average annual precipitation varies from 375 mm at the Town of Peace River to 467 mm at Beaverlodge, located in the southern portion of the basin (Environment Canada 1982). More than 70 percent of the total annual precipitation falls during summer, and June and July are the wettest months. There was considerable variation in monthly precipitation within the Peace River Basin during the time of the synoptic surveys (Fig. 4). At Grande Prairie, monthly precipitation totals were below long-term normals. However, precipitation during June 1988 was more than double the normal amount. In contrast, at High Level, monthly precipitation totals generally exceeded long-term normals, and the June precipitation peak was less pronounced than at Grande Prairie.

The Peace River Basin includes two major physiographic regions, the Cordillera and the Interior Plains. The Cordillera covers much of the Peace River Basin in British Columbia and the headwaters of some tributaries in Alberta. With the exception of the Rocky Mountain region, the Peace River Basin in Alberta is underlain by sedimentary bedrock of Devonian and Cretaceous ages (Green 1972). Coal seams are

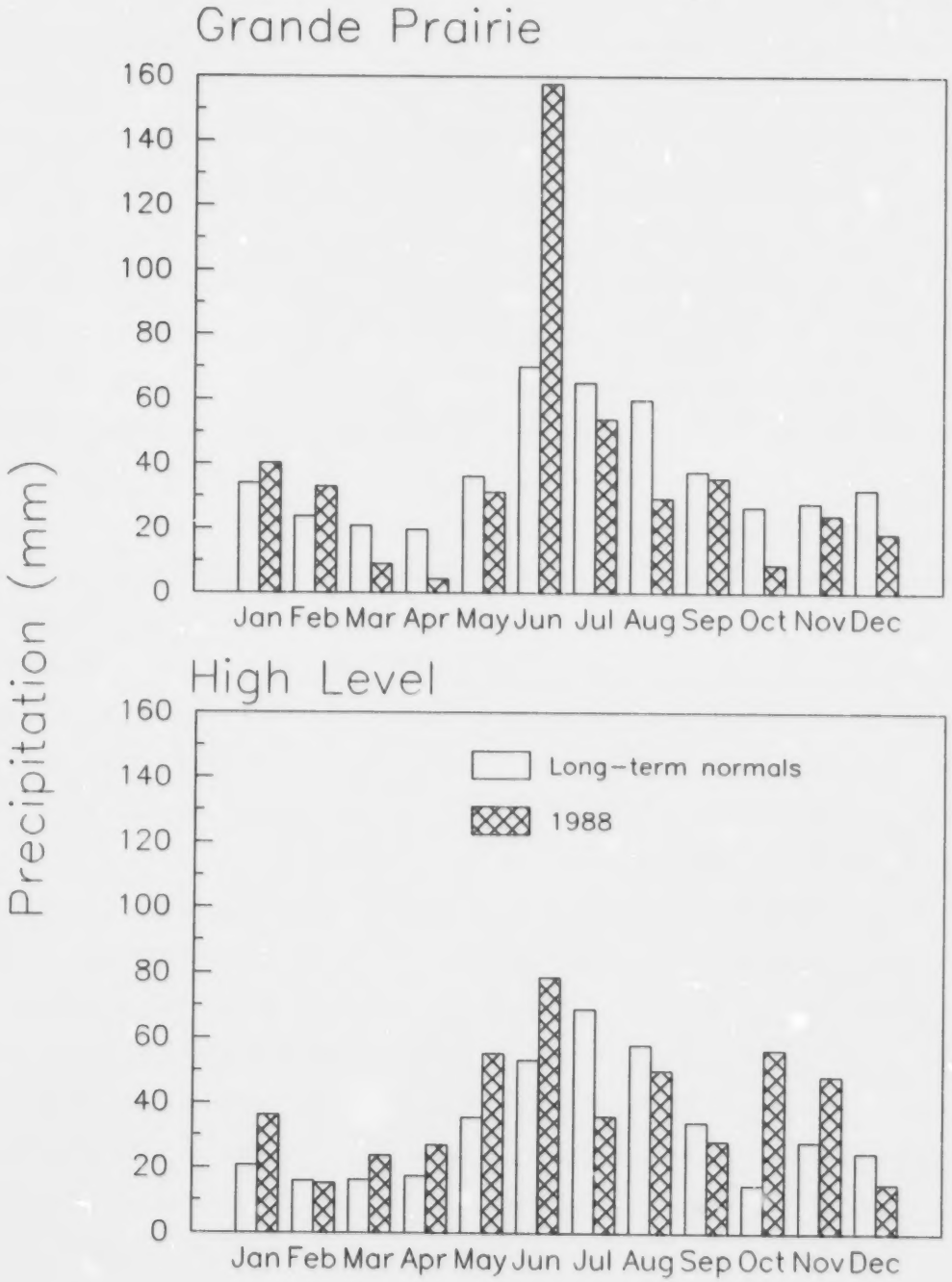

Fig. 4. Monthly precipitation in the Peace River Basin.

associated with the Upper Cretaceous Wapiti Formation south of Grande Prairie, and oil and gas fields are located throughout the region in Lower Cretaceous and Devonian formations (PRRPC 1982). The Peace River Oil Sands constitute the largest petroleum deposit in the region (PRRPC 1975). The formation is approximately 450 to 750 m below the ground surface and is located directly east and north-east of the Town of Peace River.

The topography of the Interior Plains has been modified by the effects of Pleistocene glaciation and the entire region is covered with unconsolidated glacial, aeolian, and recent deltaic deposits (Lorberg and de la Cruz 1981). The glacial deposits are comprised primarily of silt and clay ground moraine. These fine-grained sediments are susceptible to erosion from agricultural and forestry practices and gas and oil exploration (AECA 1976). The land mass of the Peace River Basin dips gently towards the northeast and consists largely of relatively flat lowlands adjacent to the steep-sided valleys of the Peace River mainstem. The major uplands are the Rocky Mountains and foothills in the southwest, the Clear Hills in the west, Buffalo Head Hills and Birch Mountains in the east, and the Caribou Mountains in the northern-most portion of the basin (Fig. 5).

Aquifers are associated with shallow sand and gravel deposits, buried channel gravels, and some sedimentary bedrock formations in the Peace River Basin (Lorberg and de la Cruz 1981). Of particular relevance to surface water quality are the buried channel gravels, many of which drain to the Peace River. However, the location and extent of these buried channels are poorly known, and groundwater chemistry data from these aquifers are sparse. Thus, the impact of groundwater discharge from these aquifers on the water quality of the Peace River is difficult to assess.

A wide variety of ecoregions are present in the Peace River Basin in Alberta (Strong and Leggat 1981). Alpine and Subalpine ecoregions

Fig. 5. Physiographic features of the Peace River Basin.

are associated with the Rocky Mountains and their foothills. Boreal Foothills and Boreal Uplands ecoregions occur in the foothills, Clear Hills and Saddle Hills. The Boreal Foothills Ecoregion is characterized by aspen, balsam poplar, and lodgepole pine, while lodgepole pine dominates the Boreal Uplands region. Soils in both ecoregions are predominantly Brunisolic, Luvisolic, and organic. A small area of Aspen-Parkland, characterized by aspen-grassland vegetation and Chernozemic soils, is located near Grande Prairie. The Boreal Mixedwood Ecoregion is the largest ecoregion in Alberta and covers most of the Peace River Basin in Alberta. Except for cultivated areas in the lowlands, most of this ecoregion is forested, primarily with trembling aspen and balsam poplar and secondarily with white spruce, black spruce, lodgepole pine and jackpine. Gray Luvisolic soils are associated with well-drained areas and organic soils with poorly drained areas of the Boreal Mixedwood Ecoregion. The Boreal Northlands Ecoregion covers much of the northern-most portion of the basin and upper elevations of the Buffalo Head Hills and Birch Mountains; mixed aspen and white spruce forests and Luvisolic soils are predominant. The Boreal Subarctic Ecoregion is associated with the highlands of the Caribou Mountains and Buffalo Head Hills. Widely-spaced black spruce and organic soils underlain by permafrost characterize this region.

Peatlands cover large areas of the northern portion of the Peace River Basin, in particular the Buffalo Head Hills, Birch Mountains, and Caribou Mountains (Fig. 6). Runoff water from peatlands tends to be highly coloured, variably buffered, slightly acidic, and contains high concentrations of dissolved organic carbon (in particular humic and fulvic acids and phenolics), phosphorus, nitrogen, biochemical oxygen demand, aluminum, iron, manganese, and zinc (Turchenek et al. 1987). Drainage from peatlands may affect the water quality of many of the northern tributaries, in particular the Cadotte, Wolverine, Boyer, Mikkwa, Wabasca, and Wentzel rivers (Fig. 6).

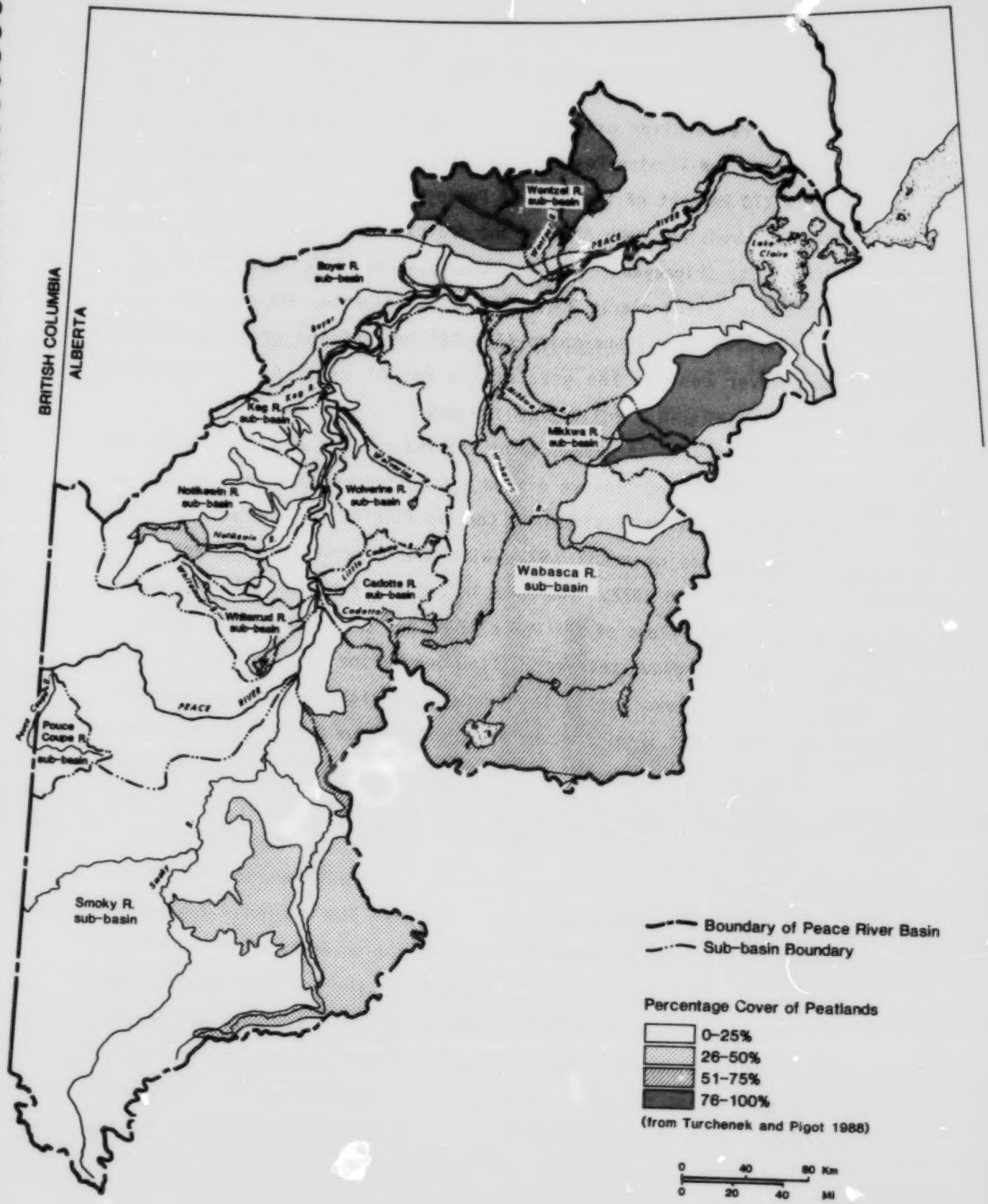

Fig. 6. Peatland distribution in the Peace River Basin.

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3.2 HYDROLOGIC AND GEOMORPHIC FEATURES

The Peace River originates in north-eastern British Columbia, flows through Williston Reservoir and the W.A.C. Bennett Dam and enters Alberta 170 km west of the Town of Peace River. The river flows north-easterly across northern Alberta and drains into the Slave River, 50 km north of Ft. Chipewyan (Fig. 1). The total drainage area of the Peace River Basin covers nearly 300,000 km^2. In Alberta, its drainage basin covers approximately one-third (173,000 km^2) of the province and the Peace River conveys the greatest volume of water of any river in Alberta.

Flow regulation commenced on the Peace River mainstem in January 1968 as a result of closure of the W.A.C. Bennett Dam and the initial filling of Williston Reservoir. Construction of the dam and reservoir filling carried on until 1972, with the reservoir going into full operation in June 1972. The main influence of the Bennett Dam on the natural monthly flows of the Peace River has been the redistribution of discharge throughout the year. Flow regulation has resulted in lower mean monthly flows during the summer and higher mean monthly flows during the winter (Fig. 7). In addition, maximum daily flood peaks have been substantially reduced while the minimum daily flows have increased as a result of flow regulation (Table 3).

Flow regulation has also affected the ice regime of the Peace River (G. Fonstad, 1990, person. commun.). The river remains ice-free for a considerable distance downstream of the Bennett Dam. The maximum extent of the ice-free reach depends upon the severity of the winter and the magnitude of the discharge. On average, the ice-free reach extends 178 km downstream of the Bennett Dam to near the B.C.-Alberta border. The furthest upstream advance of the ice cover recorded to date was 88 km downstream of the dam. In contrast, in one year the ice-free reach extended 20 km downstream of Dunvegan to a total distance of 325 km

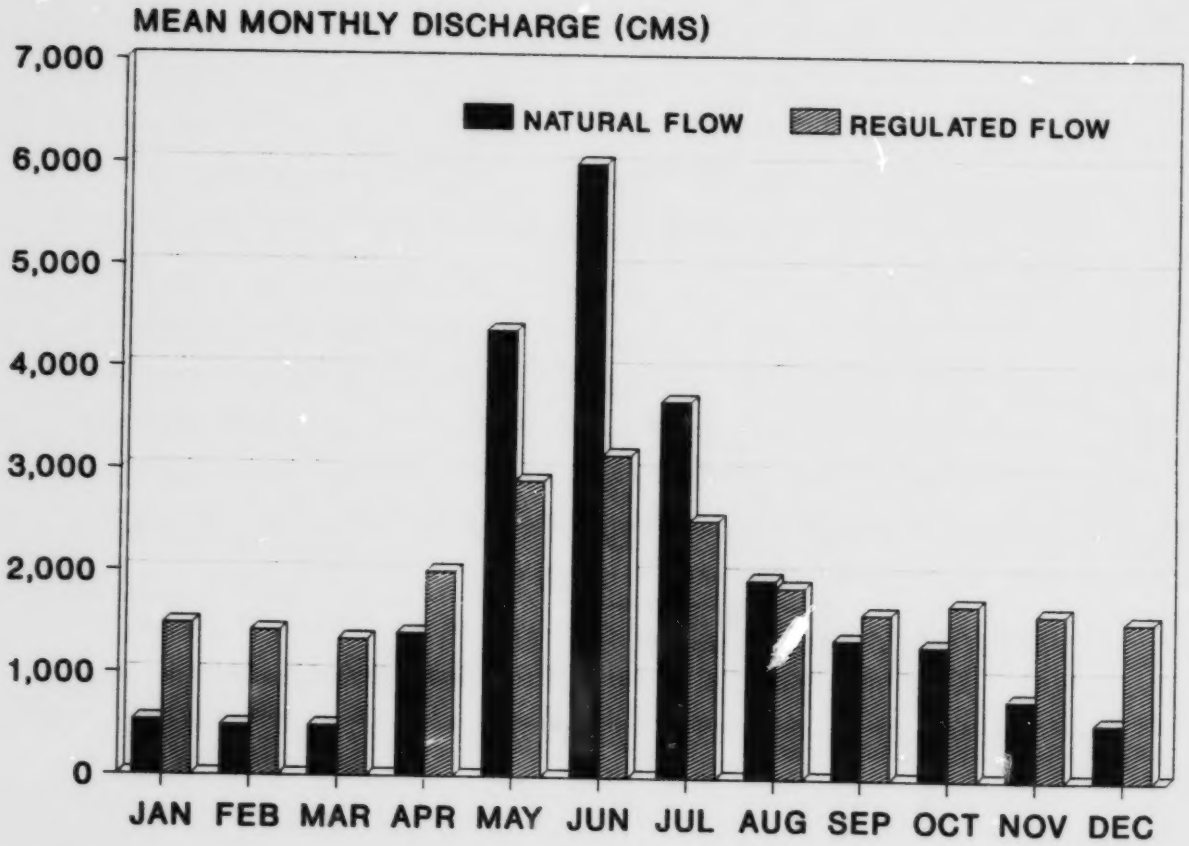

Fig. 7. Natural and regulated flows in the Peace River at the Town of Peace River.

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Table 3. Annual natural and regulated extremes of discharge in the Peace River at the B.C.-Alberta border.

Year	Maximum Daily Discharge (m^3/s)		Minimum Daily Discharge (m^3/s)	
	Natural	Regulated	Natural	Regulated
1968	8690	4080	273	217
1969	5580	2320	170	272
1970	7310	2690	286	515
1971	8860	5320	201	654
1972	12700	5890	238	566
1973	6710	3030	292	855
1974	6740	3940	152	677
1975	4980	2410	241	549
1976	8440	5320	245	620
1977	7790	4640	185	637
1978	5950	2590	80	586
1979	7560	3260	150	493
1980	5100	2600	96	507

Natural flows were synthesized.

downstream of the dam.

The higher discharge in the early winter months has delayed the onset of freeze-up at the Town of Peace River by several weeks, from early November to late December. Further downstream at Ft. Vermilion, average freeze-up has been delayed by only a couple of weeks, from early to mid November. The delay in freeze-up is caused by (1) an increased volume of water in the river that has to cool down to the freezing point before ice can form, and (2) the constant release of water with a temperature above 0 ^{o}C from the hypolimnion of the reservoir. The higher discharge in the river in early spring has also brought forward the onset of break-up at the Town of Peace River by about two weeks, from late to mid April. At Ft. Vermilion, the river ice breaks-up in early May, and the timing of break-up has changed little as a result of the dam.

The mean annual runoff to the Peace River at Peace Point is approximately 66,300,000 dam^3, of which 46,300,000 dam^3 (or two-thirds) originates outside of Alberta (van der Giessen 1982). The mean annual flow in the Peace River is 1,630 m^3/s at Dunvegan and it increases to 2,170 m^3/s at Peace Point, near the confluence with the Slave River (Table 4). Nearly 75 % of the increased flow between Dunvegan and Peace Point can be accounted for by two tributaries - the Smoky and Wabasca rivers, with mean annual flows of 358 and 98 m^3/s, respectively. Mean annual flows of the other tributaries to the Peace River in Alberta are considerably lower (Table 4).

In the Peace River, annual 7Q10 flows (the lowest flows that occur, on average, over seven consecutive days in a 10-year period) are 22 to 35 % of mean annual flows (Table 4). 7Q10 flows are not usually applied to regulated streams; they are presented here only to provide an indication of the magnitude of low flows. In contrast to the flow-regulated Peace River, 7Q10's in the two largest tributaries, the Smoky and Wabasca rivers (both of which are unregulated), are only 6 and 4 %,

Table 4. Drainage area and flows in the Peace River mainstem and selected tributaries.

Site	Drainage Area	Mean Annual[1] Flow	Annual[1,4] 7Q10
	km^2	m^3/s	m^3/s
MAINSTEM			
Hudson's Hope, B.C.[2]	69,900	1,150	269
Taylor, B.C. (d/s of Pine R.)	97,100	1,420	503
Peace River[3]	186,000	1,930	590
Peace Point[3]	293,000	2,170	761
TRIBUTARIES			
Pouce Coupe River d/s Henderson Cr.[2]	2,850	7.44	0.01
Smoky River at Watino[3]	50,300	358	23.0
Whitemud River near Dixonville[3]	2,010	7.33	0.01
Notikewin River at Manning[3]	4,680	14.1	0.00
Keg River at Hwy. 35[3]	667	3.00	0.00
Wabasca River at Wadlin Lake Road[3]	35,800	97.5	4.21

NOTE: Drainage area and flows are for the indicated gauge location, not necessarily the mouth.

[1]Based on regulated flows for mainstem and period of record for tributaries (as indicated in references below).

[2]Environment Canada 1989c.

[3]Environment Canada 1989b.

[4]7Q10's flows apply only to unregulated streams, however, they have been calculated here to give an indication of the relative magnitude of low flows in the Peace River.

respectively, of mean annual flows. For the other tributaries, 7Q10 flows are very low or nil.

Flood peaks in the Peace and Smoky rivers generally occur in late May to early June, coincident with the snowmelt runoff event in the headwaters of these rivers (Fig. 8). The flood peak in the Wabasca River occurs approximately one month earlier, in late April to early May, coincident with the earlier snowmelt runoff in its headwaters. During the summer of most years, summer rainstorm events produce an additional flood peak.

From May to August 1988, flows in the mainstem were below long-term, regulated medians, while flows during the fall and winter of 1988 were similar to or greater than long-term, regulated medians (Fig. 8). With the exception of the February-March 1989 survey, flows in the Smoky River during the synoptic surveys were generally less than the long-term, lower quartile of flows. In contrast, flows in the Wabasca River were nearly five-fold higher than the long-term median during the July 1988 survey; during the remaining surveys, flows were within the long-term quartiles. The high July flows were probably a result of the abnormally high precipitation in the headwaters of the Wabasca River during June 1988 (Fig. 4).

The elevation of the Peace River at the confluence of the Parsnip and Finley rivers in British Columbia is approximately 579 m, at the B.C.-Alberta border is 375 m, and at the confluence with the Slave River is 207 m (Fig. 9). The river drops 168 m in Alberta for an average gradient of 0.16 m/km. A major feature of the gradient profile is the river drop of 9.5 m at the Vermilion Chutes, located 112 km downstream of Fort Vermilion (Fig. 2). The highest average slope in the river occurs in the reach between Hudson's Hope and Taylor, B.C. at 0.5 m/km. The lowest average slope occurs in the reach between Carlson's Landing and the mouth of the river at 0.04 m/km. Salient features of the gradient profile for Alberta are the steep gradients in the reach from

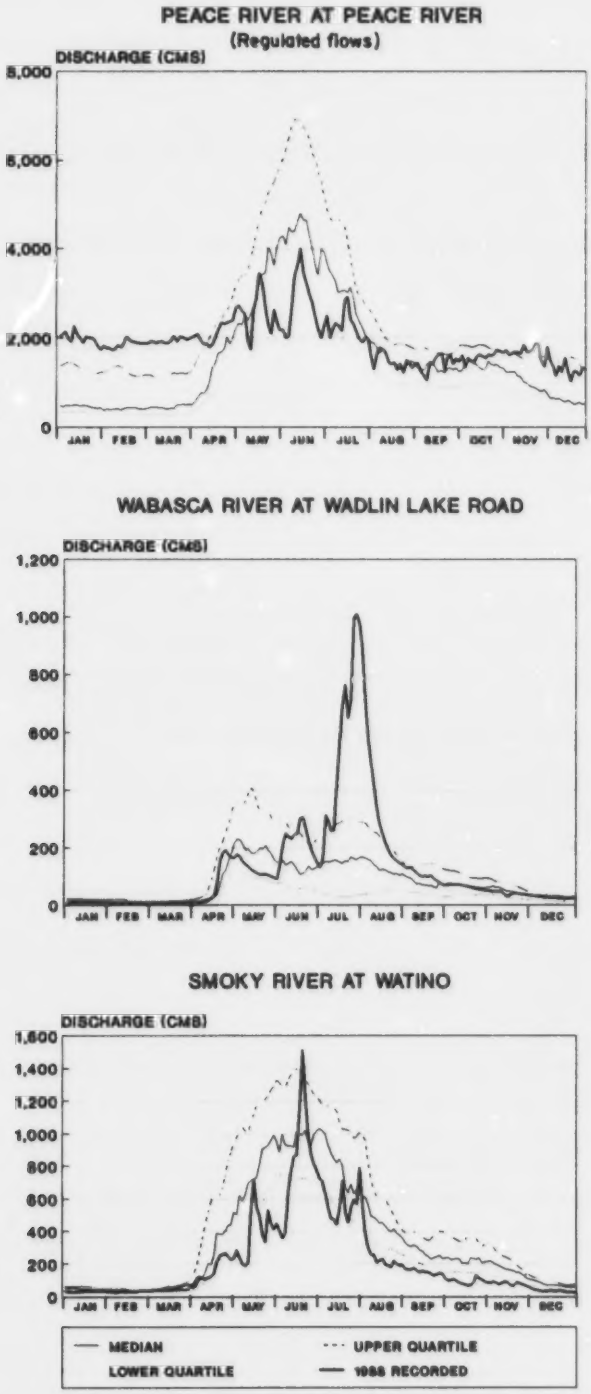

Fig. 8. Summary hydrographs.

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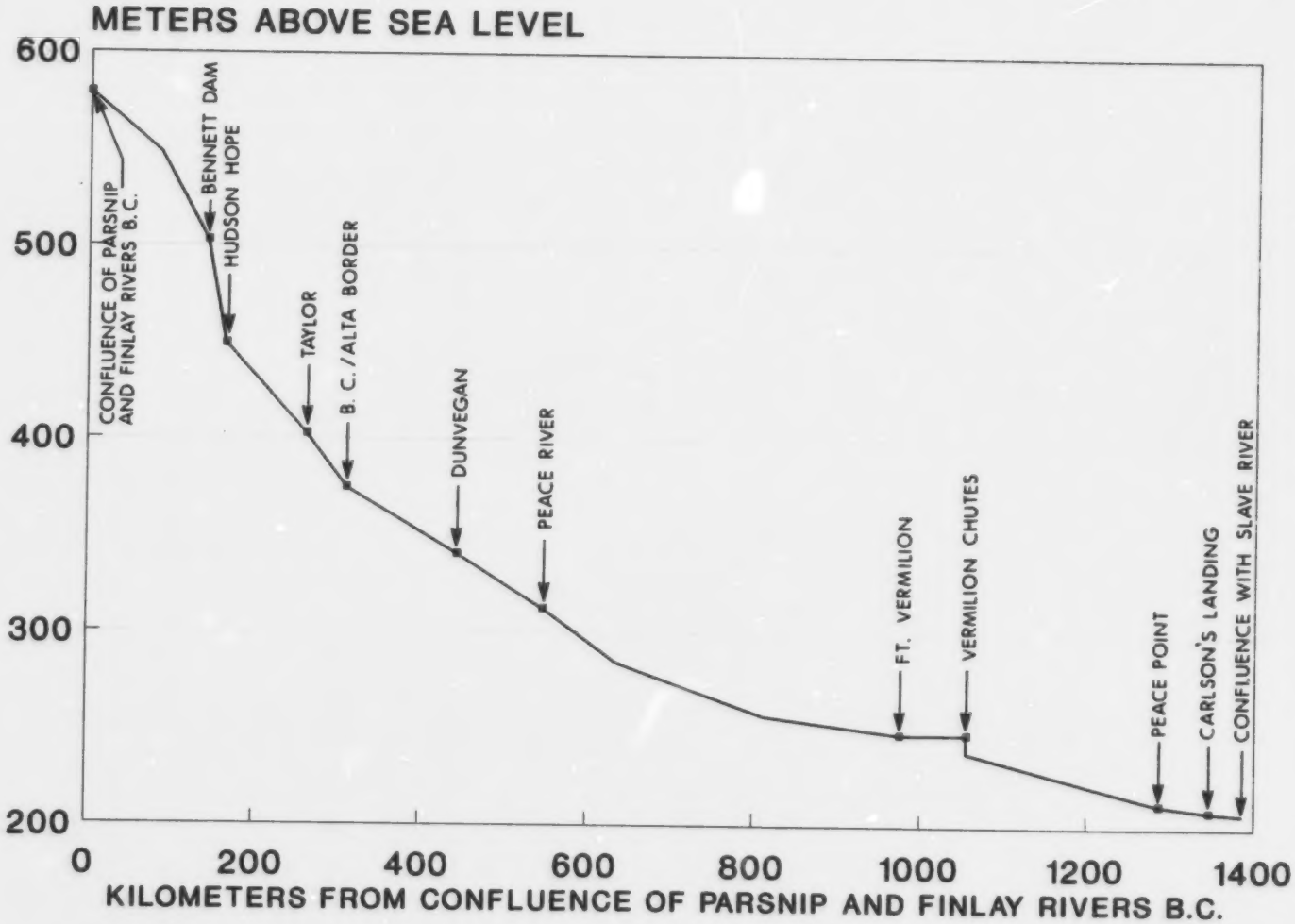

Fig. 9. Gradients along the Peace River.

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the border to near Manning, an intermediate reach from Manning to near Carcajou, and low gradients in the reach downstream of Carcajou. Coincident with the decrease in slope along the river is a decrease in flow velocity. The mean velocity at the Town of Peace River is 0.99 m/s and it decreases to 0.76 m/s at Peace Point.

From Williston Reservoir to Carcajou, the channel bed consists of gravel over easily erodible bedrock (shale) and the channel bank material is primarily gravel overlain by silt (Kellerhals et al. 1972). In the lower reaches on the river, from Carcajou to Peace Point, the channel bed is predominantly sand with local gravel over easily erodible shales and the channel bank consists of silt, sand and gravel. In addition to a change in channel bed and bank material between the upper and lower reaches of the river, there is also a change in the size fractions of suspended solids. At both the Town of Peace River and Peace Point, silt comprised approximately 55 % of the total suspended solids (Fig. 10). However, at Peace Point, clay was relatively more important and sand less important than at the Town of Peace River. The increased importance of the smaller-sized particles at Peace Point is a result of: (1) decreased flow velocities at Peace Point and subsequent settling of the heavier sand particles, and (2) the higher clay content of channel bed and bank materials in the lower reaches of the river.

3.3 BASIN DEVELOPMENT

The entire Peace River Basin is sparsely populated and largely undeveloped. Only four communities have populations exceeding 3,500 - Fort St. John (13,355) and Dawson Creek (10,544) in B.C. and Grande Prairie (27,000) and Peace River (6,400) in Alberta (Sova 1989). Historically, agriculture has been the major economic activity in the Peace River Basin; this is the northern-most commercially important agricultural region in North America. In B.C., most agricultural activity is limited to the north bank of the river (Butcher 1987). In

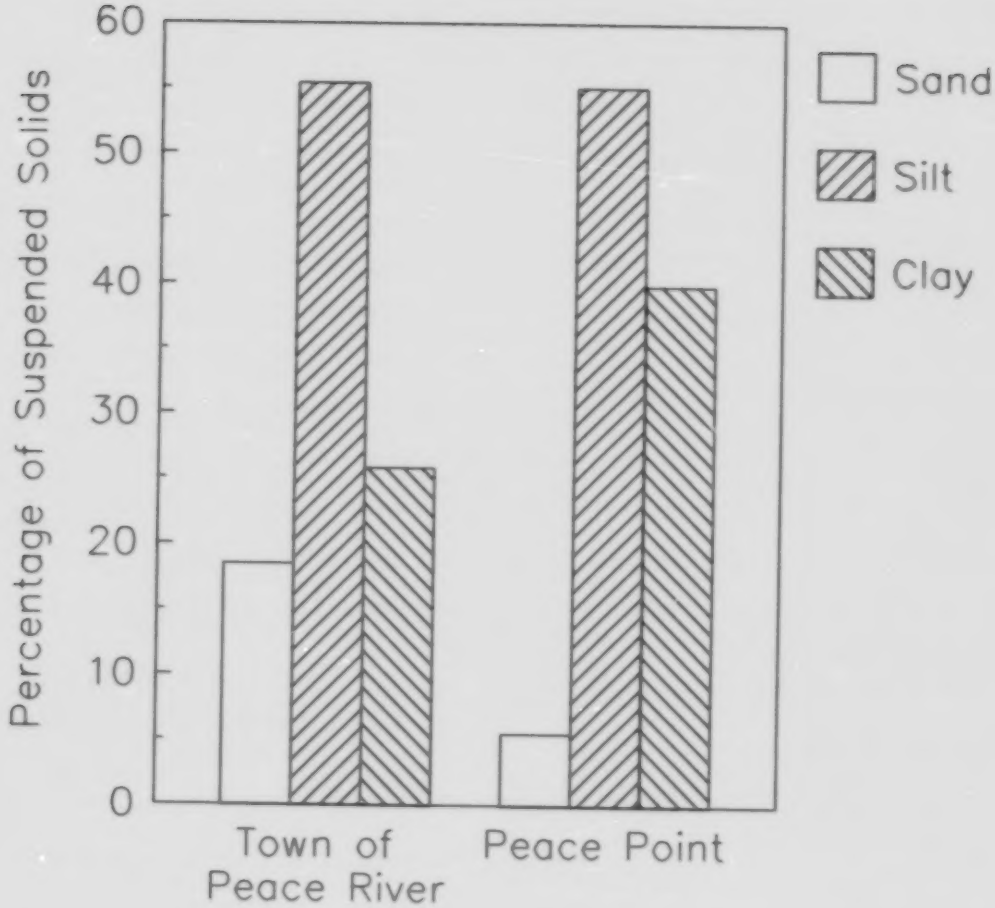


Fig. 10. Size fractions of suspended solids in the Peace River mainstem (Environment Canada 1986, 1987, 1988, 1989a).

Alberta, agricultural activity occurs in the lowlands surrounding Grande Prairie, Valleyview, High Prairie, Fairview, the Town of Peace River, and to a lesser extent in the High Level-Fort Vermilion district (PRRPC 1982). Hydroelectric development of the Peace River began with the closure of the Bennett Dam in 1968. Recently, the economic base of the area has diversified with forestry and petroleum industries. Logging, sawmill, pulp mill, and petroleum industries are important employers in the B.C. portion of the basin. At present, the two largest industries in the Alberta portion of the basin are both associated with forestry and are located near Grande Prairie - the Canadian Forest Products Ltd. sawmill and the Procter and Gamble Cellulose Ltd. pulp mill (Anon. 1988). Daishowa Canada Ltd.'s 1000 tonne per day bleached kraft pulp mill, which is under construction near the Town of Peace River, is scheduled to begin production in the summer of 1990. Existing and projected developments in the Peace River Basin with respect to water resource management issues in Alberta are summarized by van der Giessen (1982).

3.4 EFFLUENTS

The water quality of the Peace River at the B.C.-Alberta border is influenced by the sum of upstream point and diffuse waste discharges. The primary point sources to the mainstem are treated municipal effluent from Fort St. John and industrial wastewater from Petro-Canada's petroleum refinery and Fibreco's chemithermomechanical pulp mill, both at Taylor. Increases in fecal coliforms have been reported downstream of Fort St. John's municipal effluent, and increases in water temperature, surface oil films, and concentrations of phenols, nutrients, and some metals have been observed downstream of Petro-Canada's refinery (Butcher 1987). No adverse impacts have been observed in the water quality of the Peace River in Alberta as a result of discharge from Fibreco's pulp mill (Shaw and Noton 1989). Diffuse sources of wastewater to the Peace River

include runoff of fertilizer and herbicides from agricultural land, increased sediment deposition and erosion from logging activities, and oil spills from pipelines (Butcher 1987).

The major effluents that discharge to the Peace River system in Alberta are listed in Table 5. The largest point source is the Procter and Gamble pulp mill at Grande Prairie, which discharges treated effluent to the Wapiti River, a tributary of the Smoky River. The effect of the pulp mill on the receiving water has been assessed previously (Noton et al. 1989). Non-compliance in the receiving water, which was attributed to the effluent, was observed for colour, phenols, total phosphorus, manganese, and total coliforms. The largest municipal effluent load is from Grande Prairie (Nagendran et al. 1989). It may contribute to increased bacterial counts and changes in benthic invertebrates in the Wapiti and Smoky rivers (Noton et al. 1989). In addition to the five municipal effluents that continuously discharge to the Peace River system (Table 5), 38 sewage lagoons discharge once per year (fall), and nine discharge twice per year (spring and fall) (Nagendran et al. 1989).

Water from flowing, abandoned oil wells may also affect surface water quality in the Peace River Basin. One such well, Peace River Oils #1 (Fig. 3), was sampled during the 1988-1989 synoptic surveys, and it has been subsequently determined that discharge from the well adversely affects water quality and biota in the mainstem, immediately downstream of the outflow (Alberta Environment 1989).

Table 5. Major effluents discharging to the Peace River system in Alberta.

Source	Type/ Treatment System	Receiving Water	Approximate Discharge[1] m^3/s
Industrial Effluents			
Procter and Gamble	kraft pulp mill/ secondary	Wapiti R.	0.70
Alberta Power Ltd. power plant	process wastewater	Smoky R.	0.017
Peace River Oils #1[5]	flowing well	Peace River	0.04
Continuously Discharging Municipal Effluents			
Dawson Creek, B.C.[4]	aerobic and anaerobic lagoons	Dawson Creek[3]	0.063
Grande Cache	mech/ext aer	Smoky River	0.014
Grande Prairie[2]	mech/RBC	Wapiti River[5]	0.18
Manning	mech/aer lagoon	Notikewin River	0.011
Peace River[2]	anaer lagoon	Peace River	0.026
Peace River Correctional Inst.[2]	oxi ditch	Peace River	0.0026

mech - mechanical; ext aer - extended aerobic; RBC - rotary biological contactor; oxi ditch - oxidation ditch; anaer - anaerobic lagoon; aer - aerobic lagoon.

[1]Discharge from Nagendran et al. (1989), except as noted.
[2]Sampled during 1988-1989 synoptic surveys.
[3]Tributary of the Pouce Coupe River.
[4]No discharge from January to March (Butcher 1985).
[5]Alberta Environment (1989)

4. RESULTS AND DISCUSSION

Water quality data collected during the 1988-89 synoptic surveys are listed in Appendix V and a summary of data collected at Environment Canada's station at Dunvegan is included in Appendix VI. The following sections focus on those data. Where appropriate, data from other federal and provincial monitoring programs are also presented.

4.1 GENERAL DATA EVALUATION

4.1.1 Flow-Dependency

It is well known that concentrations of some constituents are related to river discharge (Harned et al. 1981, Hirsch et al. 1982, Smith et al. 1982). For some dissolved constituents, loading rates to rivers tend to be relatively constant because the main source is point-source discharge or natural base flow from groundwater. For those constituents, increased discharge from precipitation, snowmelt, or reservoir release has a dilution effect (Hirsch et al. 1982). Concentrations of total dissolved solids, major ions, and dissolved metals tend to decrease with flow (Harned et al. 1981). On the other hand, the particulate matter content of rivers tends to increase with flow as a result of increased scouring of river beds and banks. Thus, concentrations of those variables associated with particulate matter (e.g., suspended solids, turbidity, nutrients) tend to increase with flow.

At Dunvegan, over 100 different variables have been analyzed and 30 of them were suitable for evaluation of the relationship between concentration and discharge. For the others, there were too few data or too many censored data. Of the variables evaluated, 15 were flow-dependent, i.e., the slope of regression of concentration versus discharge was significantly different from 0 (at $\underline{P}<0.05$) and $\underline{r}^2$ was greater than 0.10 (Table 6). For these variables, the best-fit was a

Table 6. Flow-independent variables and regressions of concentration ([X]) versus discharge (Q) for flow-dependent variables in the Peace River at Dunvegan.

Flow-Independent Variables	
Alkalinity	Arsenic (Diss.)
Boron (Diss.)	Calcium
Chloride	Coliforms (Total)
Dissolved Oxygen	Organic Carbon (Diss.)
pH	Potassium
Silica (Reactive)	Sodium
Sulphate	Total Dissolved Solids
Total Dissolved Phosphorus	

Flow-Dependent Variables	Regression	r^2	df	P
Bicarbonate	log[X] = 2.273 - 0.075logQ	0.105	112	<0.001
Magnesium	log[X] = 1.199 - 0.119logQ	0.184	115	<0.001
Specific Conductance	log[X] = 2.612 - 0.0958logQ	0.103	130	<0.001
Total Hardness	log[X] = 2.268 - 0.0817logQ	0.105	119	<0.001
Colour (True)	log[X] = -1.554 + 0.839logQ	0.104	84	<0.001
Iron (Extr.)	log[X] = -4.770 + 1.401logQ	0.136	44	<0.02
Organic Carbon (Part.)	log[X] = -4.574 + 1.407logQ	0.157	120	<0.001
Manganese (Extr.)	log[X] = -6.519 + 1.535logQ	0.206	43	<0.01
Nitrogen (Diss.)	log[X] = -1.943 + 0.338logQ	0.106	121	<0.001
Nitrogen (Part.)	log[X] = -5.475 + 1.363logQ	0.130	120	<0.001
Nitrogen (Total)	log[X] = -2.952 + 0.738logQ	0.148	120	<0.001
NO_2+NO_3-N	log[X] = -4.243 + 0.889logQ	0.168	126	<0.001
Phosphorus (Total)	log[X] = -5.814 + 1.408logQ	0.149	128	<0.001
Suspended Solids	log[X] = -4.864 + 1.970logQ	0.158	127	<0.001
Turbidity	log[X] = -3.450 + 1.488logQ	0.134	130	<0.001

Units are in mg/L, except for specific conductance (μS/cm), true colour (RCU), turbidity (NTU) and flow (m^3/s).

$\log_{10}$-$\log_{10}$ regression. Even though the regressions were highly significant, the correlation between concentration and discharge was poor; for all regressions, r^2 was less than 0.21. The weak correlation probably reflects the reservoir origin of much of the water of the Peace River at Dunvegan. Poor correlations between constituent concentrations and flow have been reported downstream of other reservoirs in Canada and the United States (Smith et al. 1982; Weagle 1987). A reservoir will pool water and release a more constant quality of water than would occur naturally in the river. The presence of Williston Reservoir probably accounts for the lack of flow dependency for the dissolved constituents that are usually inversely correlated to flow, such as TDS and the major ions. All Dunvegan data that were tested for flow-dependency were collected after the closure of the Bennett Dam.

4.1.2 Seasonal Trends

There were sufficient historical data from Dunvegan to assess seasonality of 33 variables (Table 7). There were significant monthly differences in 7 of 18 flow-independent variables. For 12 of 15 flow-dependent variables, there were significant monthly differences in the actual and/or flow-adjusted concentrations. For one constituent, magnesium, seasonality of the unadjusted but not the flow-adjusted concentrations was significant. For two others, colour and dissolved nitrogen, seasonality of the flow-adjusted but not the actual concentrations was significant. Seasonal changes in concentration may arise from a number of factors such as seasonal fluctuations in discharge, temperature, photoperiod, and human activity (e.g., agricultural practices). These results and possible causes for seasonality are discussed in more detail in the following sections.

Table 7. Kruskal-Wallis test for seasonality of data collected in the Peace River mainstem at Dunvegan, 1977 to 1988.

Variables	Test Statistic		Monthly or Quarterly Data
	Unadjusted	Flow-Adjusted	
Flow-Independent Variables			
Alkalinity	15.4		M
Arsenic (Diss.)	4.7		Q
Boron (Diss.)	-5.5		Q
Calcium	10.5		M
Chloride	-2.5		M
Coliforms (Total)	20.1*		M
Dissolved Oxygen	114.8*		
Fecal Streptococci	1.7		M
Organic Carbon (Diss.)	34.3*		
pH	-94.5		M
Phenolics	9.59		M
Potassium	33.1*		M
Silica (Reactive)	30.3*		M
Sodium	128.4*		M
Sulphate	686.5*		M
Total Dissolved Solids	16.9		M
Total Dissolved Phosphorus	-7.3		M
Flow-Dependent Variables			
Bicarbonate	15.9	16.7	M
Colour (True)	-4.9	40.9*	M
Hardness (Total)	8.1	7.5	M
Iron (Extr.)	18.2*	17.2*	Q
Organic Carbon (Part.)	77.5*	74.8*	M
Magnesium	22.8*	15.8	M
Manganese (Extr.)	10.6*	14.0*	Q
Nitrogen (Diss.)	-5.5	25.8*	M
Nitrogen (Part.)	208.8*	72.4*	M
Nitrogen (Total)	71.7*	53.0*	M
NO_2+NO_3-N	40.2*	73.7*	M
Phosphorus (Total)	76.6*	66.3*	M
Specific Conductance	15.7	16.4	M
Suspended Solids	65.8*	74.1*	M
Turbidity	65.3*	67.6*	M

*$P<0.05$
Monthly data: critical value at $\alpha=0.05$ is 19.7
Quarterly data: critical value at $\alpha=0.05$ is 7.8

4.1.3 Long-Term Trends

There were sufficient data from Dunvegan to test 35 variables for long-term monotonic trends (Table 8). There were significant increases in 3, decreases in 11, and no change in 21 of the variables tested. Serial correlation was present in approximately one-third of the variables for which monthly data were available. The use of quarterly data eliminated serial correlation for all data except total coliforms and specific conductance (actual values). Thus, the apparent significant trends detected in these two variables may have been an artifact of serial correlation and were not considered to indicate actual trends. For most flow-dependent variables, similar results were obtained for both actual and flow-adjusted concentrations. However, for two flow-dependent constituents, $(NO_2^- + NO_3^-)$-N and particulate nitrogen, there were significant decreases in flow-adjusted, but not actual values.

There were no significant long-term trends for flows in the Peace River, as measured on the dates that water quality samples were collected. This suggests that observed long-term trends may be due to changes in processes that deliver the constituents to the river (e.g., river impoundments, land-use changes, pollution abatement efforts, natural causes) rather than changes in the hydraulic regime of the river. These results and possible causes for the observed trends are discussed in more detail in the following sections.

4.1.4 Mass Transport

For the 1988-89 synoptic surveys, mass transport (or load) of constituents was calculated for selected sites along the mainstem and for all tributaries and effluents that were sampled. The flow and concentration data are included in Appendix V and the mass loads are given in Appendix VII. Mass loads were computed as mean concentration

Table 8. Kendall tests for long-term trends in data collected in the Peace River mainstem at Dunvegan, 1977 to 1988. For flow-dependent variables, results are given for both actual and flow-adjusted (inside brackets) concentrations.

Variable	Test Statistic		Trend	
	Kendall	Seasonal Kendall	Actual	Flow-Adjusted
Boron (Diss.)	3.29**		increase	
Coliforms (Total)		2.14*	increase[1]	
Dissolved Oxygen		2.71**	increase	
Fecal Streptococci	4.42**		increase	
α-BHC	-5.03**		decrease	
Calcium	-4.96**		decrease	
Colour (True)		-2.09*(-2.54**)	decrease	decrease
Hardness (Total)	-2.78**(-5.03**)		decrease	decrease
Magnesium	-2.93**(-5.28**)		decrease	decrease
Nitrogen (Diss.)		-3.88**(-3.40**)	decrease	decrease
Nitrogen (Part.)		-2.28*(-0.66)	decrease	none
Nitrogen (Total)		-2.62**(-2.14*)	decrease	decrease
NO_2+NO_3-N		-2.53**(-1.72)	decrease	none
pH	-3.21**		decrease	
Silica (Reactive)		-3.53**	decrease	
Alkalinity	0.79		none	
Bicarbonate	1.94(0.26)		none	none
Chloride		-0.28	none	
Coliforms (Fecal)	1.26		none	
Discharge		1.44	none	
Iron (Extr.)		0.25(1.15)	none	none
Manganese (Extr.)		0.84(1.31)	none	none
Organic Carbon (Diss.)		1.09	none	
Organic Carbon (Part.)		-1.36(1.13)	none	
Potassium		-0.57	none	
Phenolics	1.29		none	
Phosphorus (Total Diss.)		-1.46	none	
Phosphorus (Total)		-0.81(0.05)	none	none
Sodium		-1.02	none	
Specific Conductance		-0.66(-3.48**)	none	decrease[1]
Sulphate	0.41		none	
Suspended Solids		-1.12(1.07)	none	
Total Dissolved Solids	-0.73		none	
Turbidity		-0.60(1.57)	none	none
Water Temperature		-0.83	none	

[1]Trend may be an artifact of serial correlation, see text.
*Two-tailed α=0.05: Critical value is 1.96.
**Two-tailed α=0.01: Critical value is 2.58.

multiplied by mean discharge, as measured during the synoptic surveys. The mass loads from the tributaries and effluents are summarized in Table 9 as a percentage of the upstream load in the Peace River mainstem (i.e., load in mainstem upstream of confluence of tributary or point of effluent discharge).

There are a number of factors that may contribute error to the mass balance:

(1) Discharge was not measured at all sites where loads were calculated. In such cases, discharge was estimated from the nearest gauged site and corrected for intervening tributaries.

(2) Concentrations of constituents vary over time and may vary spatially across the width of the river; thus, single grab samples may differ somewhat from the average water quality at a site in a river.

(3) Concentrations below detection limits were assumed to be one-half the detection limit, which may introduce errors.

(4) The sampling progression did not match the river's time of travel so that calculated loads do not represent actual mass balances for a specific flow event.

(5) Some of the constituents are non-conservative; their concentrations may change because of in-river physical, chemical, and biological processes.

Nonetheless, for most constituents, the load estimates are sufficiently accurate to aid in interpreting river water quality. Two of the effluents (Grande Prairie municipal sewage and the Procter and Gamble pulp mill effluents) discharge to tributaries of the Peace River rather than directly into the mainstem (Table 5). Their effluent loads were compared to the upstream loads in the Peace River mainstem (i.e., as measured upstream of the confluence with the Smoky River) to assess the maximum potential impact on the Peace River mainstem. In reality, assimilation and/or degradation within the Wapiti and Smoky rivers would reduce the effective loads of most constituents to the Peace River mainstem.

The greatest point-source loads for most constituents were from the Smoky and Wabasca rivers and loads from industrial and municipal

Table 9. Mean tributary and effluent load as a percent of upstream load in the Peace River, 1988-1989.

	Pouce Coupe	Peace River Corr. STP	Smoky	Grande Prairie STP	P&G	Peace River STP	Peace River Oils	Whitemud	Cadotte	Notikewin	Wolverine	Keg	Boyer	Wabasca	Wentzel
Alk.	0.5	0.0	21.3	0.0	0.1	0.0	0.1	0.7	0.8	3.2	1.5	0.7	2.7	13.6	1.2
Hard.	0.6	0.0	23.7	0.0	0.4	0.0	0.0	1.0	0.8	3.8	1.6	0.7	3.3	13.3	1.3
Ca	0.5	0.0	23.1	0.0	0.5	0.0	0.0	0.9	0.8	3.6	1.6	0.7	3.1	13.0	1.3
Mg	0.8	0.0	25.2	0.0	0.1	0.0	0.1	1.2	0.8	4.2	1.7	0.8	3.9	14.2	1.3
Na	6.4	0.0	90.7	0.1	18.6	0.1	15.8	3.4	2.3	15.3	2.9	2.5	9.2	24.9	3.1
K	0.0	0.0	20.3	0.0	1.4	0.0	0.7	1.7	1.5	5.5	2.6	1.5	3.3	14.3	0.8
HCO3	0.5	0.0	21.3	0.0	0.1	0.0	0.1	0.7	0.8	3.2	1.5	0.7	2.7	13.6	1.2
Cl	1.8	0.0	43.8	0.1	15.0	0.0	13.0	1.3	1.3	4.5	1.0	0.8	7.9	11.3	3.2
SO4	3.4	0.0	55.3	0.0	2.8	0.0	0.0	4.2	1.6	13.6	3.0	2.0	8.3	19.5	1.8
F	0.5	0.0	23.2	0.0	0.1	0.0	0.1	1.6	1.1	3.6	1.4	0.8	3.3	19.4	1.4
Silica	0.2	0.0	11.4	0.0	0.1	0.0	0.0	0.7	0.6	3.6	1.2	0.6	2.0	12.8	0.9
BOD	0.2	0.0	14.5	0.0	4.6	0.3		0.7	1.1	3.5	3.2	0.4	1.3	8.4	0.6
SS	0.2	0.0	6.2	0.0	0.0	0.0	0.0	1.9	1.1	2.7	1.9	0.3	4.0	9.1	0.1
FR	0.9	0.0	27.8	0.0	1.2	0.0	0.8	1.3	0.9	5.0	1.7	0.9	4.3	14.9	1.4
T&L	0.7	0.0	23.0	0.0	3.9	0.0		1.4	1.1	7.6	3.4	1.2	3.8	16.5	2.3
O&G	0.2	0.0	27.9	0.0	0.8	0.1	0.0	0.7	0.6	4.3	1.1	0.4	1.2	7.0	0.9
Phenols	0.6	0.0	76.8	0.0	22.3	0.1	0.3	1.8	1.4	8.2	3.3	1.3	6.5	26.9	3.5
DOC	1.0	0.0	19.3	0.0	2.6	0.0	0.0	2.1	1.9	11.4	5.5	1.8	4.5	26.9	3.0
TOC	0.9	0.0	19.3	0.0	2.2	0.0	0.0	2.0	1.8	11.0	5.5	1.7	4.4	26.1	2.9
TP	0.2	0.0	7.2	0.1	0.4	0.1	0.0	1.7	1.1	2.9	2.3	0.4	3.3	10.2	0.3
TDP	0.5	0.0	26.1	2.0	4.7	1.7		1.7	2.0	6.5	2.9	1.1	4.6	21.0	1.3
NH3-N	1.4	0.0	61.5	2.3	4.6	3.3	5.7	2.5	2.1	9.0	6.4	1.6	5.5	21.5	2.3
NO2+NO3-N	0.7	0.0	14.0	0.4	0.2	0.0	0.0	0.9	1.1	2.9	1.8	0.5	6.6	43.5	1.8
TKN	0.6	0.0	15.1	0.1	1.2	0.1	0.2	1.4	1.7	5.5	3.6	0.9	4.8	20.0	1.5
TN	0.6	0.0	15.0	0.1	1.1	0.1	0.2	1.3	1.6	5.3	3.5	0.8	4.9	21.0	1.5
T. Col.	0.7	0.0	18.7	1.1	6.6	105.4	0.0	0.7	0.6	9.4	2.0	0.3	2.6	8.5	0.3
F. Col.	0.4	0.0	4.6	0.6	0.3	79.8	0.0	0.3	0.3	10.1	2.7	0.3	1.5	1.2	0.3
S.P.C.	0.5	0.0	40.4	0.1	25.9	0.2	0.0	0.4	0.4	0.5	0.3	0.1	1.4	0.9	0.7
Total Al	0.2	0.0	18.8	0.0	0.1	0.0	0.0	1.5	1.3	1.5	1.9	0.2	2.4	4.3	0.1
Diss. Al	0.1	0.0	13.0	0.0	2.6	0.0	0.0	0.9	0.3	3.8	1.2	0.4	2.5	7.8	1.2
Total As	0.3	0.0	7.4	0.0	0.0	0.0	0.0	2.3	1.2	2.5	1.3	0.3	5.2	10.5	0.4
Diss. As	0.5	0.0	18.9	0.0	0.1	0.0	0.0	1.0	1.0	3.6	1.4	0.5	3.3	20.7	1.2
Total Ba	0.2	0.0	15.1	0.0	0.2	0.0	0.9	0.7	0.6	2.5	1.2	0.3	3.8	7.4	0.5
Diss. Ba	0.3	0.0	24.8	0.0	0.3	0.0	0.0	0.5	0.5	2.4	1.0	0.4	1.8	9.7	1.1
Total B	0.5	0.0	16.6	0.0	0.1	0.0	1.0	1.0	1.0	7.7	2.4	1.3	3.1	11.3	1.2
Diss. B	1.5	0.0	27.5	0.1	0.2	0.0	0.0	1.3	1.2	8.9	1.8	1.6	2.8	18.5	1.7
Total Cr	1.1	0.0	12.9	0.0	0.5	0.0	0.0	0.4	0.1	5.4	1.5	0.2	3.7	9.6	0.5
Total Cu	0.3	0.0	14.6	0.0	0.1	0.0	0.0	0.7	0.3	3.3	1.9	0.6	3.1	5.6	0.6
Total Fe	0.1	0.0	16.9	0.0	0.0	0.0	0.0	1.6	0.5	4.3	2.3	0.5	1.8	8.3	0.4
Diss. Fe	0.4	0.0	21.0	0.0	1.4	0.0		2.5	1.1	17.4	4.5	1.7	3.0	14.9	2.2
Total Pb	0.2	0.0	15.9	0.0	0.2	0.0	0.0	0.8	0.4	3.8	1.6	0.4	3.4	8.1	0.7
Total Mn	0.9	0.0	9.4	0.0	0.7	0.0	0.0	3.8	1.9	4.4	3.1	0.7	5.1	15.2	1.1
Total Mo	0.1	0.0	15.8	0.0	0.1	0.0	0.0	2.2	1.3	2.9	1.8	0.5	5.8	7.5	0.9
Total Ni	0.2	0.0	9.5	0.0	0.1	0.0	0.0	1.3	0.6	4.4	2.0	0.5	3.2	8.4	0.5
Diss. Ni	0.5	0.0	11.7	0.0	0.5	0.0		1.8	0.7	4.0	1.9	0.7	2.6	13.8	0.8
Total Se	0.2	0.0	10.0	0.0	0.0	0.0	0.0	1.1	0.5	2.2	1.0	0.4	5.8	10.1	1.1
Total V	0.1	0.0	4.2	0.0	0.1	0.0	0.0	0.9	0.2	3.8	2.1	0.4	3.1	8.1	0.5
Total Zn	0.1	0.0	8.9	0.0	0.6	0.0	0.0	0.9	0.9	2.3	1.2	0.2	2.8	8.8	0.9

NOTE: Ft. Vermilion STP discharges approximately 20 days per year and was only sampled once during the synoptic surveys. Effluent loads from this source were negligible compared to background loads in the Peace River, thus, it was excluded from this table.

effluents were less than one percent of the upstream load in the mainstem (Table 9); notable exceptions include sodium and chloride from Procter and Gamble and Peace River Oils, phenolic compounds from Procter and Gamble, and bacteria from Peace River municipal sewage. Sodium and chloride are conservative compounds and would reach the Peace River mainstem from the Procter and Gamble effluent as part of the Smoky River. However, phenolics may be subject to degradation and the load from Procter and Gamble that would reach the mainstem is likely to be less than that estimated in Table 9. The importance of point-source loads to the water quality in the Peace River is discussed in more detail in the following sections of the report.

4.2 PHYSICAL VARIABLES

4.2.1 Water Temperature

Water temperature plays an important role in influencing physical, chemical, and biological processes in the aquatic environment. In the Peace River at Dunvegan, the warmest water temperatures occur in July, where the mean temperature from 1979 to 1988 was 16.6 ^{o}C (range 14 to 20 ^{o}C; Fig. 11). In 1988, water temperatures in some of the tributaries were considerably warmer than in the mainstem, for example, a temperature of 23.6 ^{o}C was recorded in the Pouce Coupe River during July 1988. During spring and fall of 1988, water temperatures in the Peace River near Peace Point were lower than near the B.C.-Alberta border (Appendix V). The decrease in temperature along the river is a result of the longer and colder winters in the northern compared to the southern portion of the basin. However, in the summer months the pattern was reversed. Temperatures at Peace Point were as much as 5 ^{o}C warmer than at the border as a result of (1) outflow of cool, hypolimnetic water from Williston Reservoir, (2) warming of the mainstem river water as it flowed across Alberta, and (3) mixing of

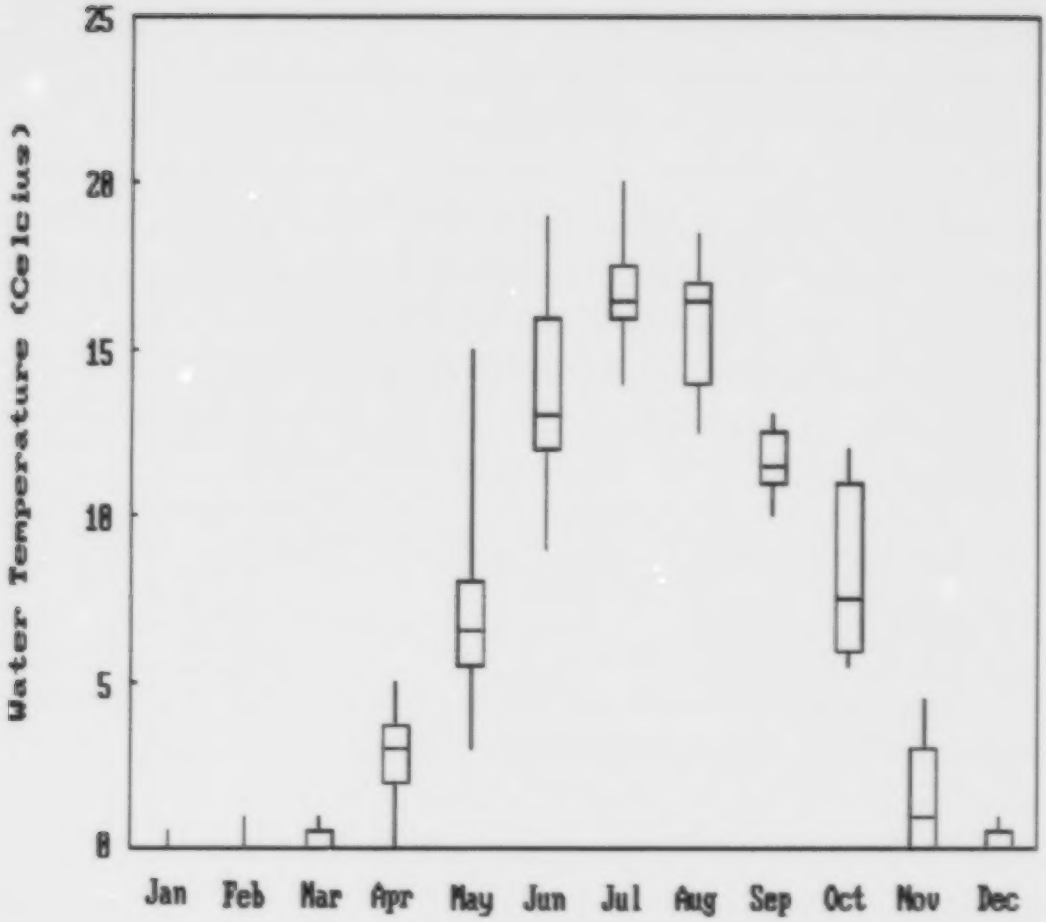


Fig. 11. Monthly water temperatures in the Peace River at Dunvegan.

relatively warm tributary water with the mainstem.

4.2.2 True Colour

True colour is the colour of a filtered water sample and results from materials dissolved in water, such as iron, humic acids, tannin and lignin (Wetzel 1983). The colour of water in both the mainstem and tributaries of the Peace River was positively correlated to concentrations of dissolved organic carbon (r=0.82, df=141, P<0.001), tannin and lignin (r=0.85, df=121, P<0.001), and dissolved iron (r=0.82, df=141, P<0.001), suggesting that these constituents may impart colour to surface waters in the Peace River Basin. In the Peace River at Dunvegan, true colour was positively correlated to discharge (Table 6). Both the actual and flow-adjusted true colour values were highest in summer and lowest in winter, although the flow-adjusted values were much less variable than the actual values (Fig. 12). This seasonal pattern for colour was similar to that observed for iron and dissolved organic carbon (Fig. 37, 50). Actual and flow-adjusted colour values decreased significantly from 1981 to 1988 (Table 8). However, the decrease in colour has been slight, only 0.4 RCU/yr (Fig. 12). The reason for the decrease in colour is not obvious since there were no concurrent significant decreases in concentrations of iron or dissolved organic carbon (Table 8) and no apparent changes in sampling or laboratory methodology. This change in colour may reflect a decrease in the colour of Williston Reservoir as a result of reservoir aging.

In 1988-89, average true colour values along the Peace River increased from approximately 25 RCU at the B.C.-Alberta border to 60 RCU in the lower reaches of the river (Fig. 13). The increase was due in part to loading from the tributaries, which had average colour values ranging from 49 to 163 RCU (Fig. 13). In particular, the Notikewin, Boyer, Mikkwa, and Wentzel rivers were highly coloured, likely as a result of seepage and runoff from organic soils and peatlands (Fig. 6).

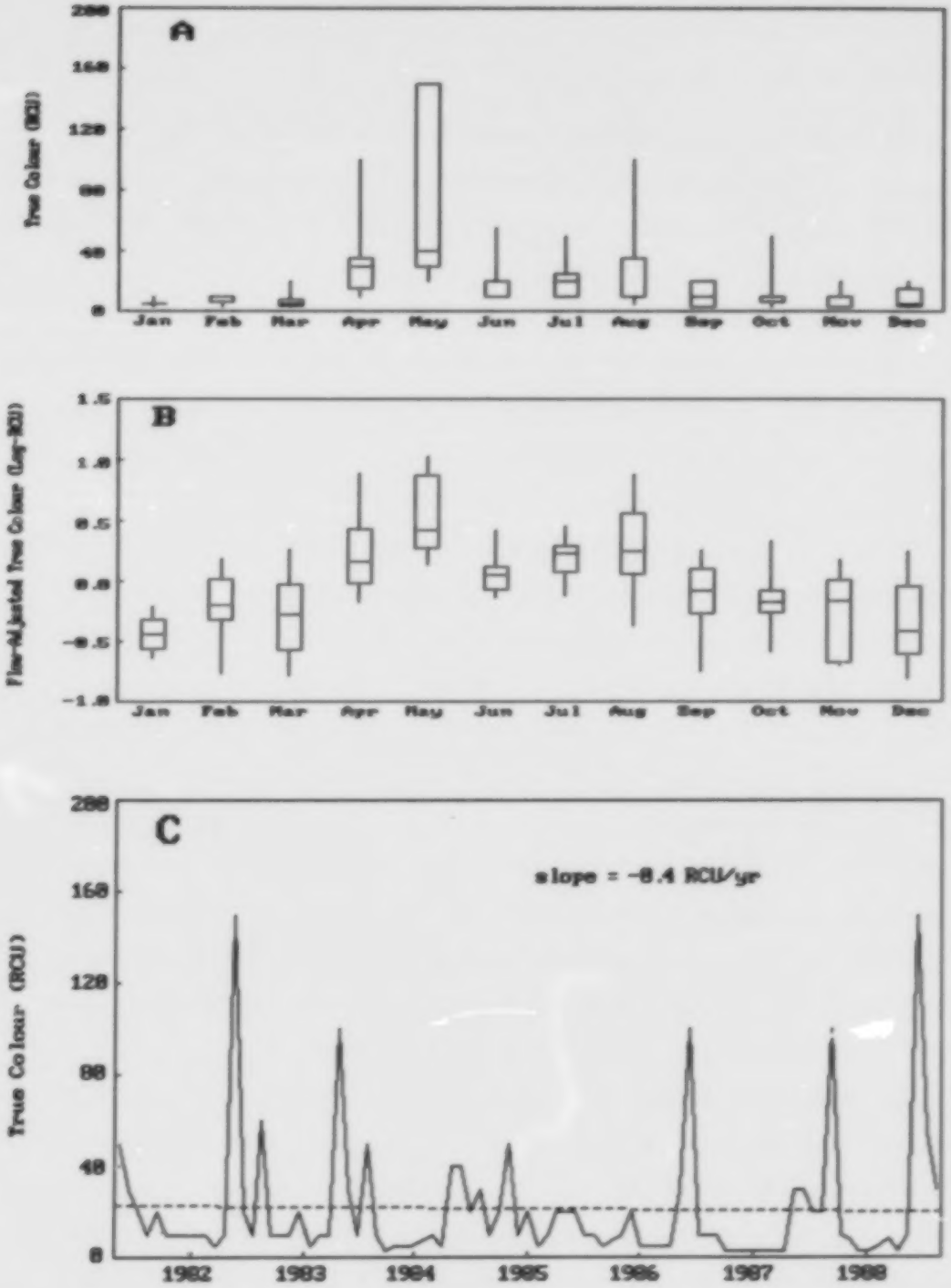


Fig. 12. Seasonal trends in (A) actual values and (B) flow-adjusted values, and (C) long-term trends in actual values for true colour in the Peace River at Dunvegan.

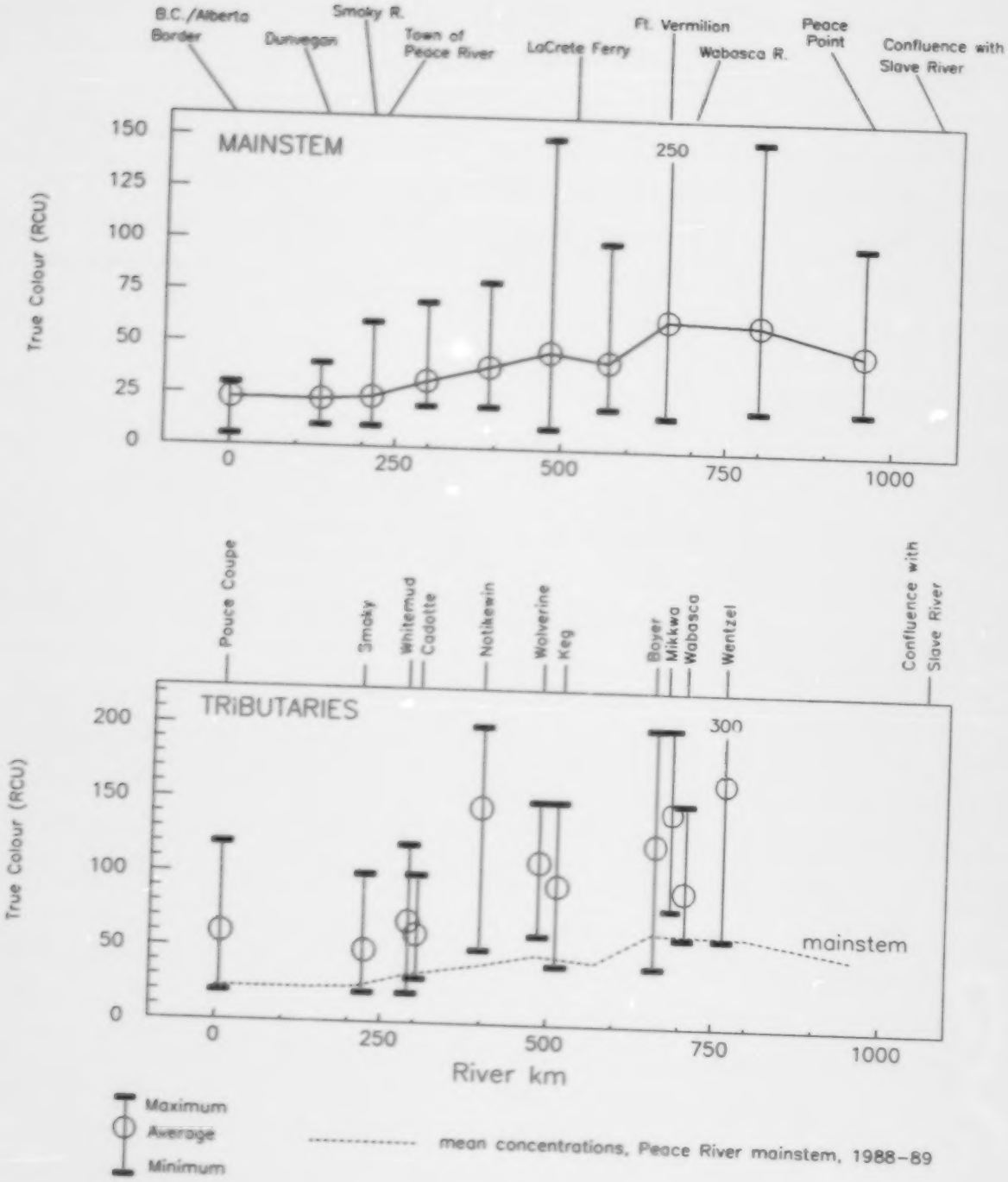


Fig. 13. True colour in the Peace River system, 1988-89.

Colour affects the aesthetic quality of water for drinking and recreation. A guideline for the colour of recreational water depends largely on the preference of the user, so there are no absolute CWQG for colour (CCREM 1987). The ASWQO for colour pertains to the effect of point-source effluents; the objective is a maximum increase of 30 units relative to background or ambient values. No such increase was observed in the Peace River mainstem, downstream of any effluent or tributary. However, non-compliance for colour has been reported in the Wapiti and Smoky rivers as a result of effluent discharge from the Procter and Gamble pulp mill (Noton et al. 1989).

4.2.3 Turbidity

Turbidity is an expression of the light scattering properties of water and is caused by the presence of particulate matter. In the Peace River at Dunvegan, turbidity was positively correlated to discharge (Table 6). Both the actual and flow-adjusted values were highest in summer and lowest in winter, following the same pattern as for suspended solids concentrations (Section 4.3.1). There were no significant changes in actual or flow-adjusted turbidity values from the Peace River mainstem at Dunvegan from 1978 to 1987 (Table 8). In 1988-89, average turbidity values increased substantially along the length of the river from about 55 NTU near the B.C.-Alberta border to 300 NTU near Peace Point (Fig. 14). Turbidity in the tributaries was generally higher than in the mainstem (Fig. 14). Turbidity was strongly correlated to suspended solids (1988-89 data: r=0.97, df=142, P<0.001); thus, the observed temporal and spatial patterns for turbidity were a result of changes in suspended solids concentrations (Section 4.3.1).

The CWQG for turbidity pertains to recreational activities such as swimming, which is likely negligible in the Peace River. The ASWQO is a maximum increase of 25 turbidity units from ambient or background values. No such increase occurred in the mainstem as a result of

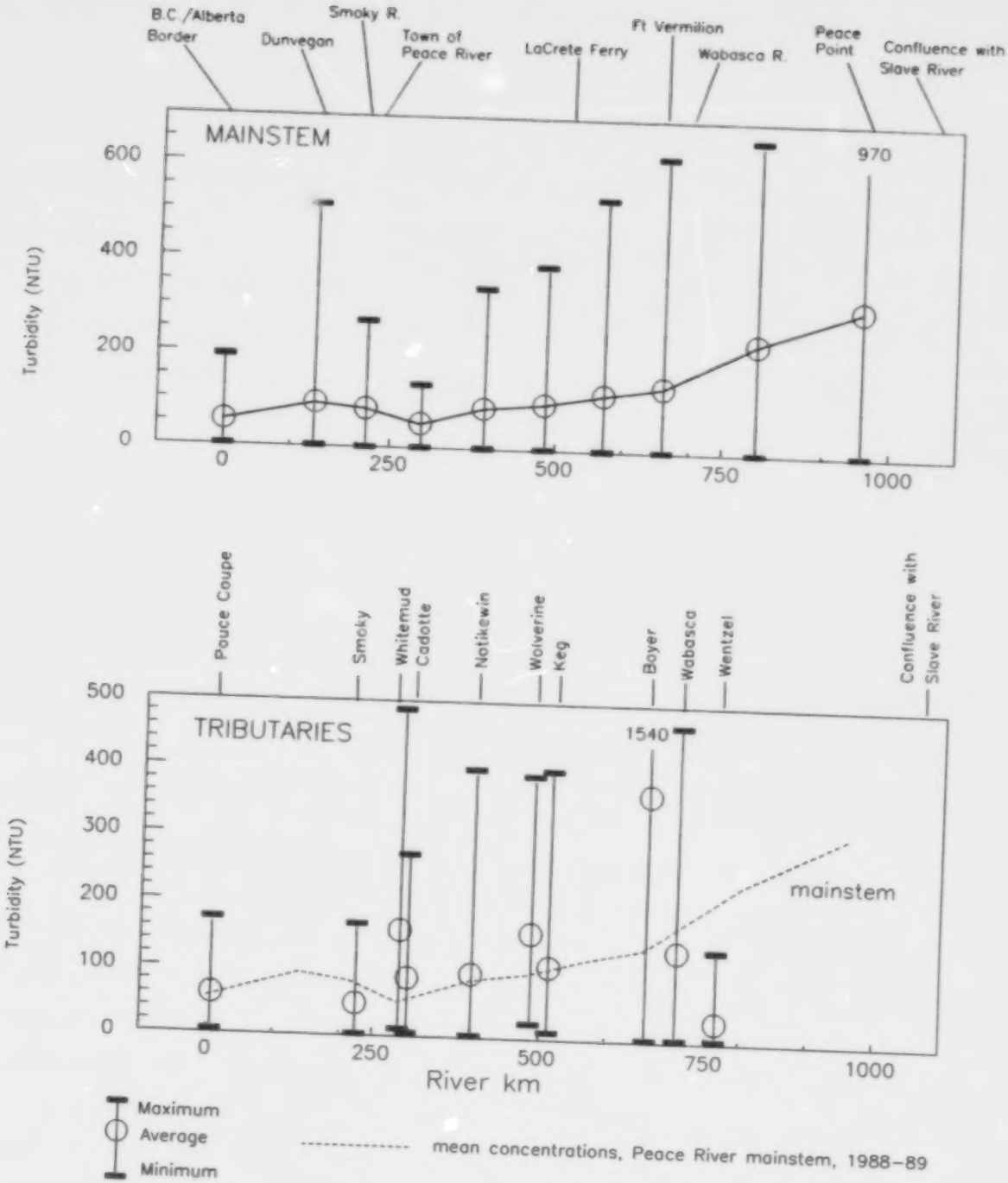


Fig. 14. Turbidity in the Peace River system, 1988–89.

effluent or tributary inputs. The increase in turbidity downstream of Ft. Vermilion is likely a natural consequence of a change in channel geomorphology (as explained in Section 4.3.1), in which case the ASWQO do not apply.

4.3 INORGANIC CONSTITUENTS

4.3.1 Suspended Solids

Concentrations of suspended solids in rivers are highly variable. Suspended solid content normally increases with discharge as a result of scouring of river beds and banks and resuspension of particulate matter. High suspended solid loads can cause siltation of river beds and smothering of biota, decreased light penetration and reduced primary productivity, and stress to aquatic biota, which may increase susceptibility to disease (Alabaster and Lloyd 1984). In addition, particulate matter may act as a sorption surface for organic compounds, nutrients, heavy metals, and bacterial degradation of particulate organic matter may contribute to deoxygenation of the water (CCREM 1987).

As in most rivers, suspended solids concentrations in the Peace River mainstem increased significantly with discharge (Table 6). Even though the fit of the regression was poor (r^2 = 0.16), both the slope and intercept were within the range reported for suspended solids-discharge regressions for other large rivers in northern Canada (Brunskill et al. 1975). These rivers all have large watershed areas, high annual discharges, and carry vast amounts of sediments.

Both the actual and flow-adjusted suspended solids concentrations in the Peace River at Dunvegan followed a strong seasonal pattern of high concentrations in spring and summer and low concentrations in fall and winter (Fig. 15). The seasonal pattern is more distinct for the flow-adjusted concentrations because (1) variability due to changes in

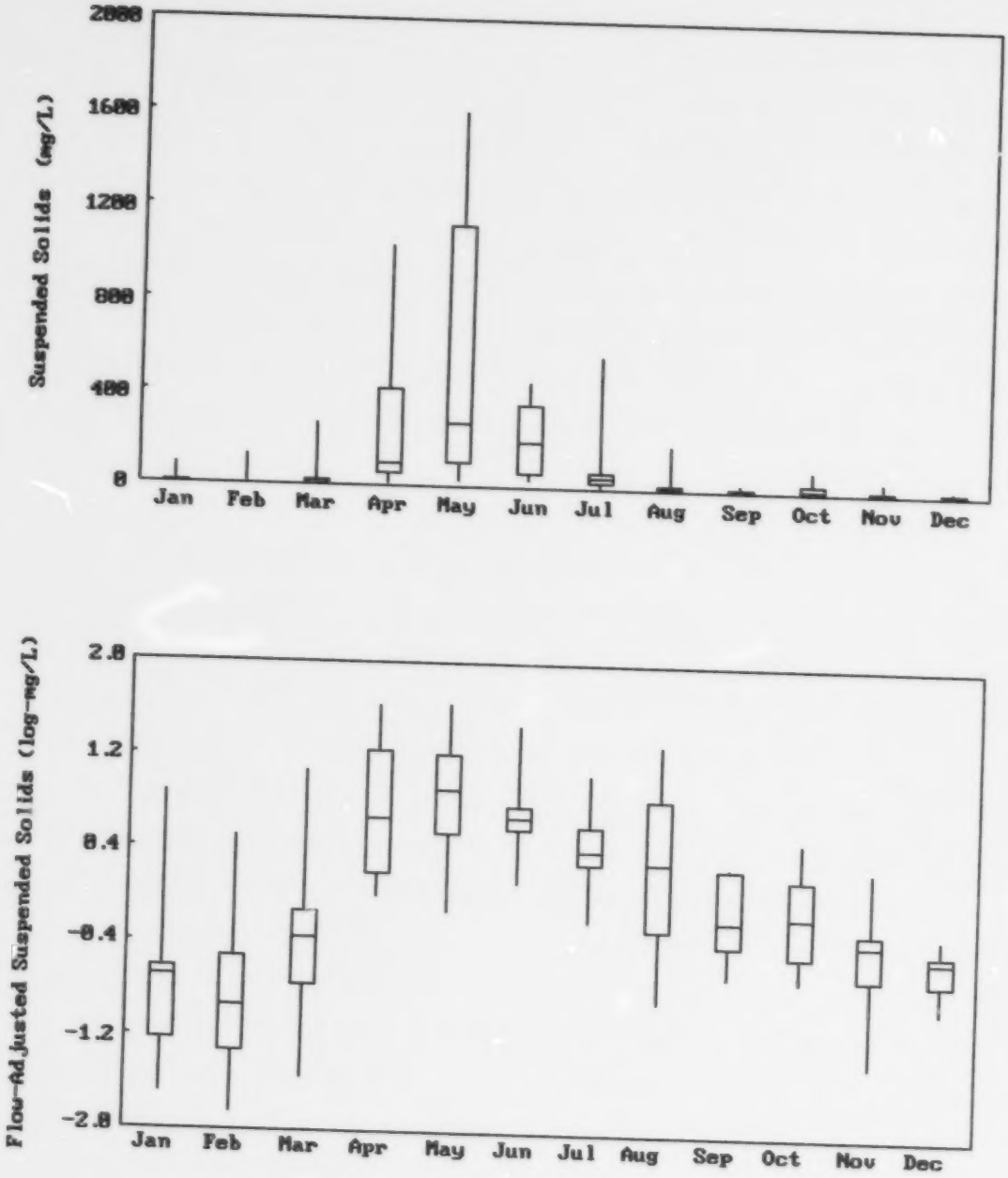


Fig. 15. Seasonal trends in actual and flow-adjusted suspended solids concentrations in the Peace River at Dunvegan.

flow have been reduced, and (2) the flow-adjusted concentrations were computed from log-transformed data. The observed seasonal pattern indicates that seasonal elements in addition to discharge in the mainstem are causing the seasonal effects. Factors that may account for this pattern include overland flow and erosion, tributary inputs, and the tendency for suspended solid concentrations to be higher on the rising limb of the hydrograph (April and May) compared to the declining limb (late June to August). Because the flow in the mainstem is regulated by the Bennett dam, the river discharge is relatively independent of local runoff events, as compared to an unregulated system. There were no long-term trends in suspended solid concentrations (Table 8).

In 1988-89, average concentrations of suspended solids in the mainstem increased gradually from 41 mg/L at the B.C.-Alberta border to 408 mg/L at Peace Point (Fig. 16). Average concentrations in the tributaries ranged from 21 mg/L in the Wentzel River to 535 mg/L in the Boyer River, although the average for the Boyer River was influenced by one very high concentration measured during the May 1988 survey (Fig. 16). The increase in suspended solids concentrations along the mainstem was largely a result of a change in channel geomorphology. In the upper reaches of the river, the channel bed is predominantly sand and gravel and the channel bank is primarily gravel whereas in the lower reaches of the river the channel bed is predominantly sand and the bank consists of silt, sand, and gravel (Section 3.2). The finer-grained sand and silt particles are more easily eroded and transported in the river than gravel, subsequently suspended solids concentrations increase along the mainstem.

The CWQG for freshwater aquatic life and the ASWQO for suspended solids are a maximum increase of 10 mg/L from ambient or background values. Such an increase was not observed in the mainstem as a result of tributary or effluent loading, rather (as noted above) the observed

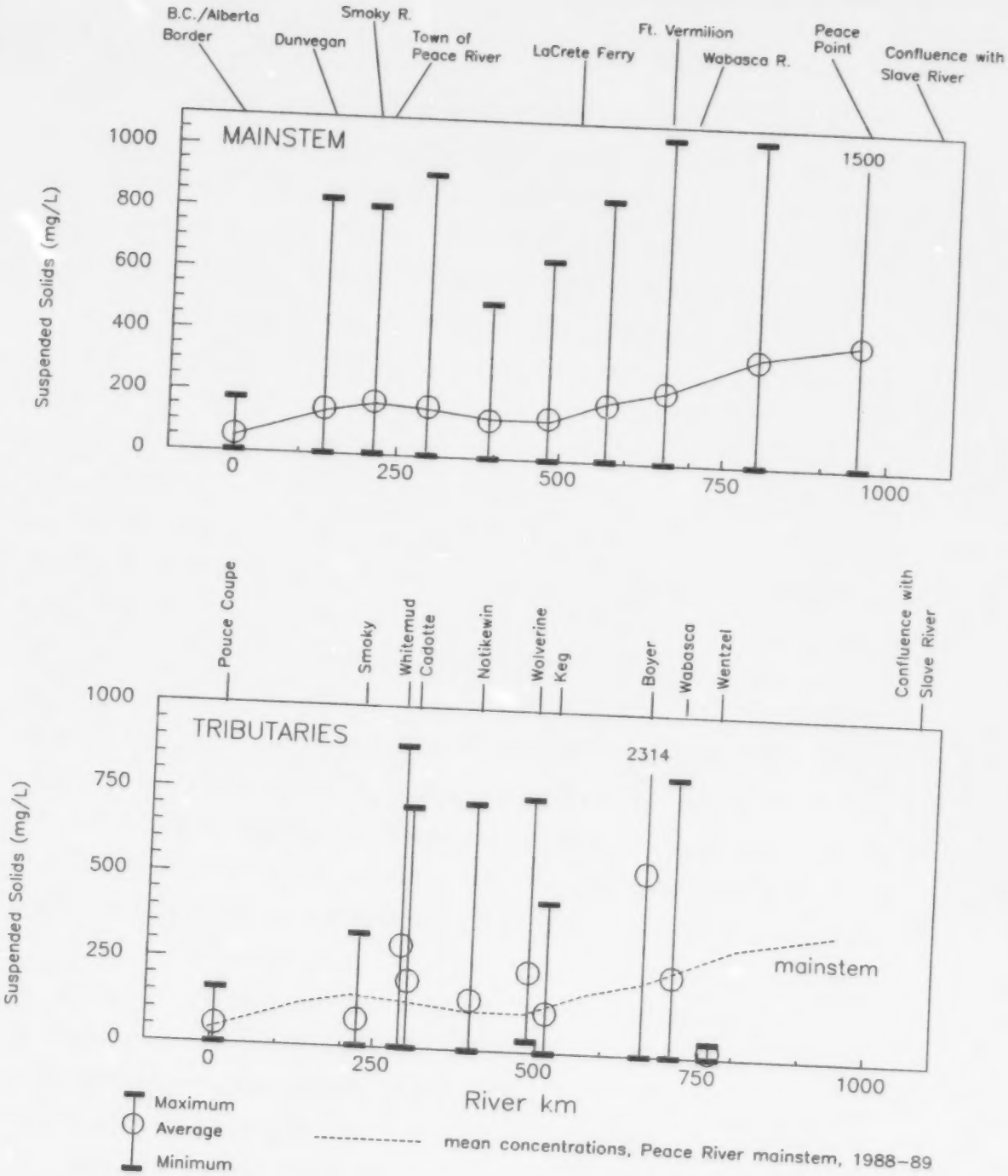


Fig. 16. Suspended solids concentrations in the Peace River system, 1988–89.

increases were likely due to natural processes, so the guidelines and objectives are not applicable.

4.3.2 pH and Alkalinity

pH is a measure of the "intensity" of the acidic or basic chemistry of a solution and is defined as the negative logarithm of hydrogen ion activity (Clesceri et al. 1989). Alkalinity refers to the acid-neutralizing capacity of water. In most surface waters, it is controlled primarily by the carbonate, bicarbonate, and hydroxide content of water and may also include contributions from borates, phosphates, silicates, and other bases (Clesceri et al. 1989).

In the Peace River at Dunvegan, neither pH nor alkalinity were correlated to discharge (Table 6) and there were no significant seasonal trends for either constituent (Table 7). However, during the synoptic surveys, the pH of the mainstem and tributaries was highest in winter and lowest in summer (Appendix V). At Dunvegan, pH values in the mainstem decreased significantly from 1978 to 1988 (Fig. 17); there were no significant changes in alkalinity concentrations during that same period (Table 8). There is no obvious reason for a decrease in pH values. It is unlikely that changes in point-source loads from upstream industrial or municipal effluents would affect pH values at Dunvegan. The impact of acidic deposition on pH would similarly be negligible due to the high buffering capacity of the river and the lack of major local atmospheric emissions that would contribute to acidic deposition. Notwithstanding the possibility that the observed trends in pH is an artifact of unrecorded changes in methodology or sampling regime, it may reflect a decrease in the pH of the Williston Reservoir as a result of reservoir aging (e.g., leaching of acidic organic matter from the soil).

In 1988-89, both pH values and alkalinity concentrations were relatively constant along the length of the Peace River (Fig. 18). The tributaries tended to be slightly lower in pH and higher in alkalinity

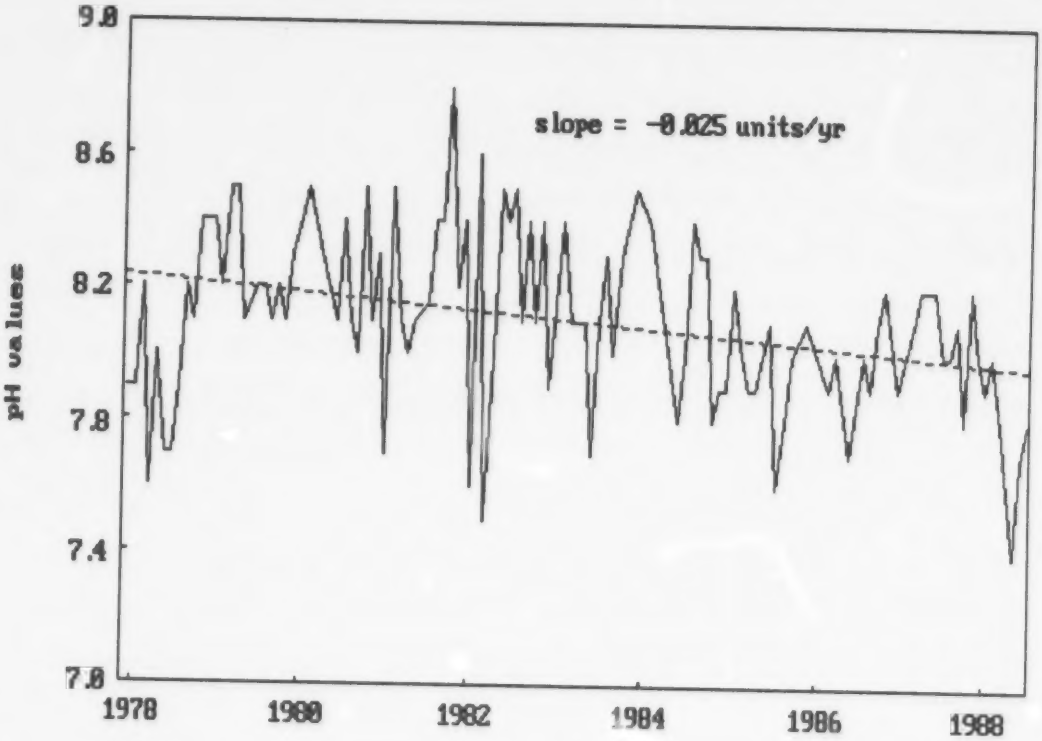


Fig. 17. Long-term trend in pH values in the Peace River at Dunvegan.

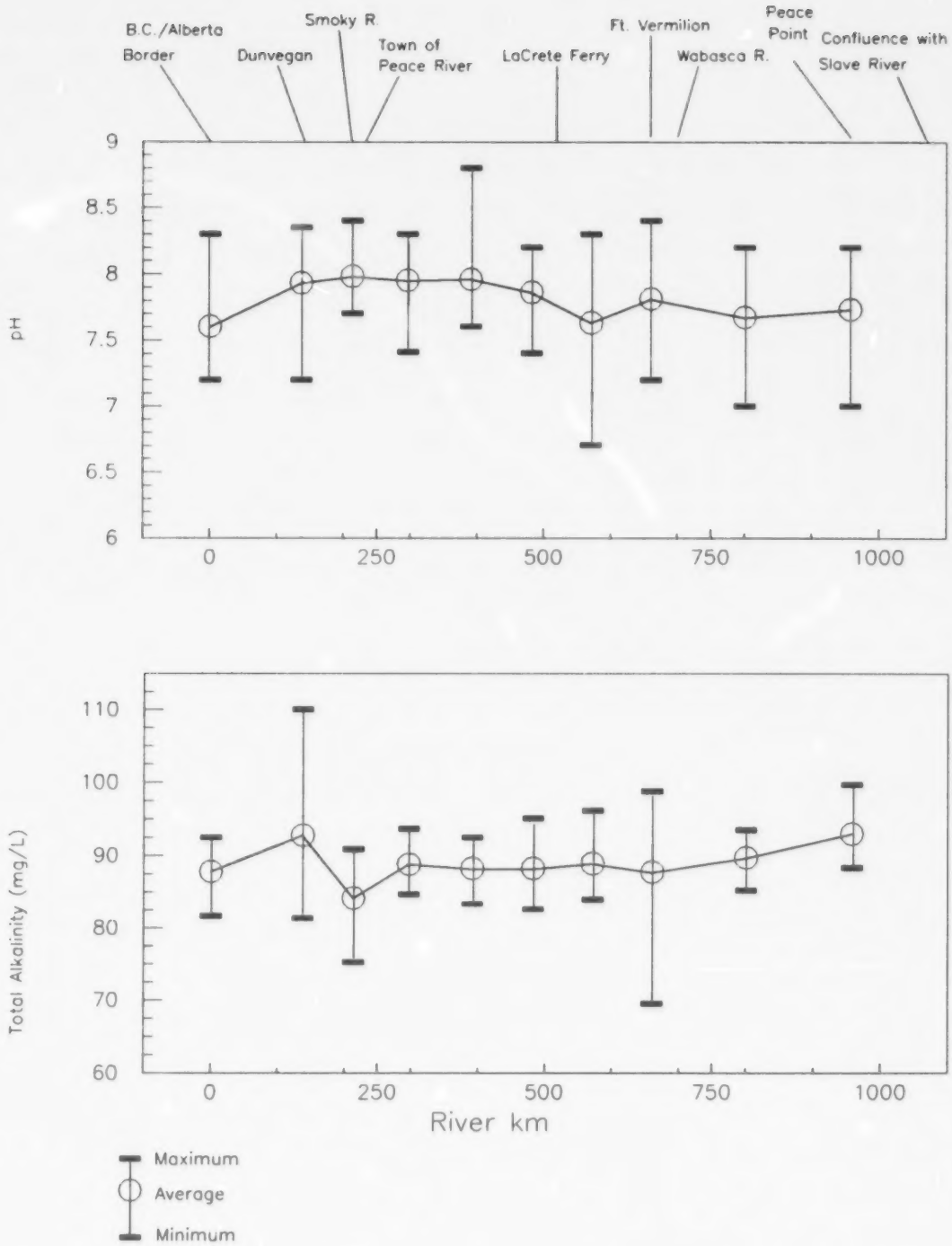


Fig. 18. pH and alkalinity in the Peace River, 1988–89.

concentrations than the mainstem (Fig. 19). The lowest pH and alkalinity values were recorded in the northern brownwater streams, likely as a result of runoff of naturally acidic, poorly-buffered water from peatlands (Turchenek et al. 1987).

All historic and 1988-89 synoptic data for the Peace River mainstem and its tributaries complied with the CWQG for freshwater aquatic life for pH of 6.5 to 9.0. However, pH values greater than the ASWQO of 8.5 was recorded at several sites along the mainstem and in the Smoky and Wabasca rivers. These relatively high pH values probably reflect natural variability in the Peace River system. There are no CWQG or ASWQO for alkalinity.

4.3.3 Total Dissolved Solids and Specific Conductance

Total dissolved solids (TDS) is a measure of the concentration of dissolved matter in water. The concentration of TDS in water depends on geochemical weathering of rocks and soils, and the influence of anthropogenic sources. Specific conductance (conductivity) is a numerical expression of water's ability to conduct an electrical current and is generally positively correlated to TDS concentrations (CCREM 1987). TDS and conductivity are highly correlated in Peace River surface waters: r=0.98, df=135, P<0.001 (1988-89 survey data).

In the Peace River at Dunvegan, conductivity decreased significantly with increasing flow (Table 6). Overall, there was also a trend of decreasing TDS concentrations with increasing flow, although the relationship between TDS and flow was obscured by a few outliers. There were no significant seasonal or long-term trends in either TDS concentration or conductivity values (Table 7,8).

In 1988-89, average TDS concentrations along the Peace River increased from approximately 100 mg/L at the B.C.-Alberta border to 125 mg/L in the reach from Ft. Vermilion to Peace Point (Fig. 20). The

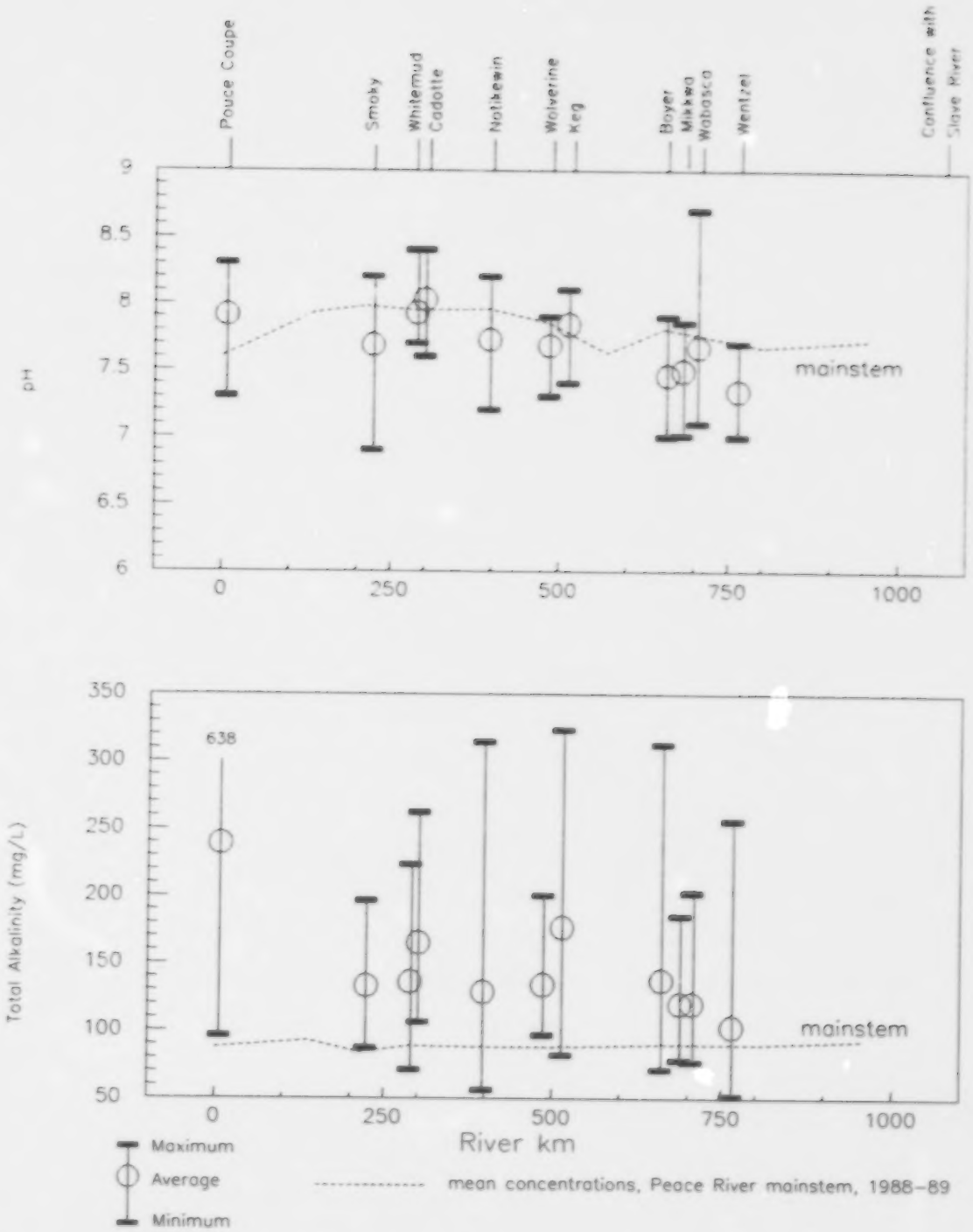


Fig. 19. pH and alkalinity in tributaries to the Peace River, 1988–89.

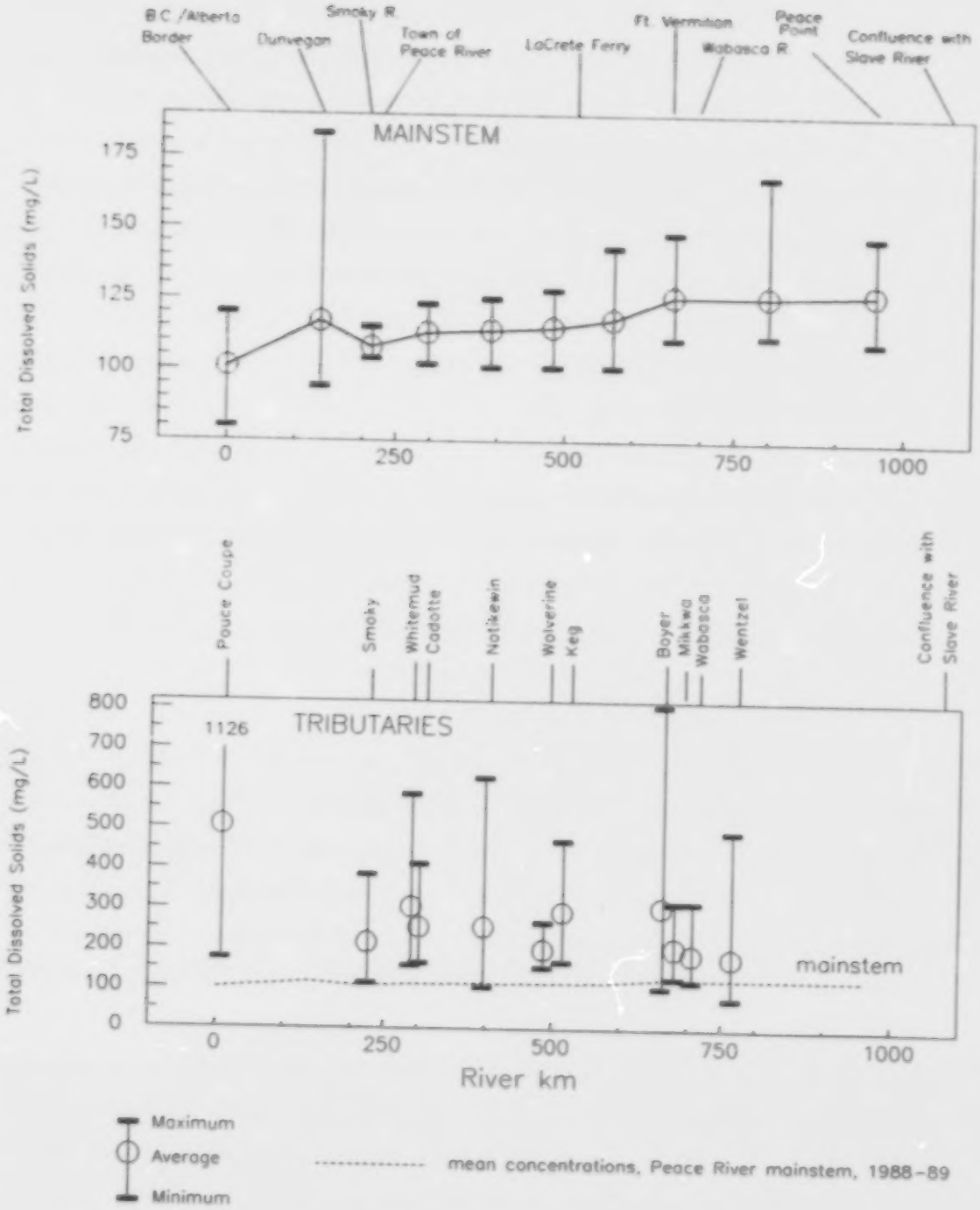


Fig. 20. TDS concentrations in the Peace River system, 1988-89.

increase was partly a result of TDS loads from the tributaries (Table 9). Non-point sources of TDS (diffuse runoff and groundwater) may also contribute to the increased concentration along the mainstem, as may desorption of cations, anions, and organic compounds from the surface of suspended particulate matter. Average TDS concentrations in all the tributaries sampled in 1988-89 were higher than in the mainstem (Fig. 20), although the high winter concentrations in the tributaries tended to accentuate this difference. The high winter TDS concentrations in the tributaries reflects the increased importance of groundwater seepage relative to surface runoff during winter base flow conditions.

The CWQG for TDS pertains to irrigation water and ranges from 500 to 3500 mg/L, depending upon the crop. All historical and survey data from the Peace River mainstem were well below the 500 mg/L guideline. A number of tributaries were, however, non-compliant with that guideline, especially during winter low flow conditions. As indicated above, these high winter values were a result of natural processes. There are no ASWQO for TDS and no CWQG or ASWQO for specific conductance.

4.3.4 Major Ions and Hardness

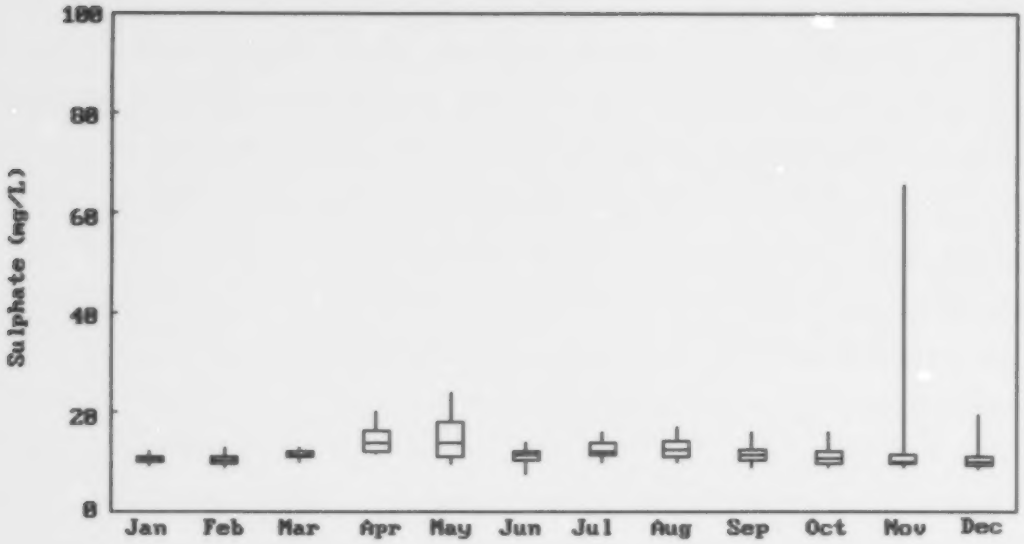
In general, the major ions calcium, magnesium, sodium, potassium, bicarbonate (and/or carbonate), sulphate, and chloride account for most of the total dissolved solids in surface waters. The major ions occur naturally in water as a result of geochemical weathering of rocks, surface runoff, and atmospheric deposition. In addition, carbonates are affected by CO_2 exchange between the atmosphere and water and by biological processes such as respiration and photosynthesis. Most of the major ions are considered conservative, and the main processes affecting their concentrations are dilution and downstream transport. Some such as calcium and bicarbonate are reactive, and their concentrations may be affected by changes in pH and temperature. Hardness is a measure of polyvalent cations dissolved in water,

predominantly the divalent cations calcium and magnesium (CCREM 1987).

Concentrations of bicarbonate, magnesium, and hardness decreased significantly with increasing discharge in the Peace River at Dunvegan; concentrations of the other major ions were independent of flow (Table 6). There were significant monthly differences in sulphate, sodium, potassium, and magnesium concentrations (Table 7). For these ions, seasonal patterns were similar: concentrations tended to be highest in April and May and lowest in January and February (Fig. 21). This pattern is similar to that for suspended solids concentrations (Fig. 15), which suggests that desorption of ions from suspended particulate matter may at least partly regulate concentrations of some major ions.

In the Peace River at Dunvegan, concentrations of calcium, magnesium, and hardness decreased significantly from 1978 to 1988 (Table 8). The long-term decrease in hardness (1.19 mg/L/yr) was a result of decreases in concentrations of calcium (0.33 mg/L/yr) and magnesium (0.09 mg/L/yr) (Fig. 22). It is unlikely that the long-term changes in calcium and magnesium were a result of changes in effluent loading to the river. Rather, they may reflect natural fluctuations in the system or long-term changes in the water quality of the Williston Reservoir as a result of reservoir aging.

In the Peace River system, similar to other northern rivers in Alberta (e.g., Noton and Shaw 1989), calcium and bicarbonate are the dominant cation and anion, respectively (Fig. 23). The ionic composition is likely controlled by the weathering of carbonate minerals in the headwaters of the Peace River mainstem and of calcareous materials in the headwaters of the tributaries (Reeder et al. 1972). The ranking for cations and anions, based on meq/L, is $Ca^{2+}>Mg^{2+}>Na^{+}>K^{+}$ and $HCO_3^{-}>SO_4^{2-}>Cl^{-}$ for the mainstem and its major tributaries. The Smoky and Wabasca rivers contain greater proportions of sodium and sulphate than does the mainstem. Thus, input from these tributaries may at least partly account for the increased proportion of these two ions in the



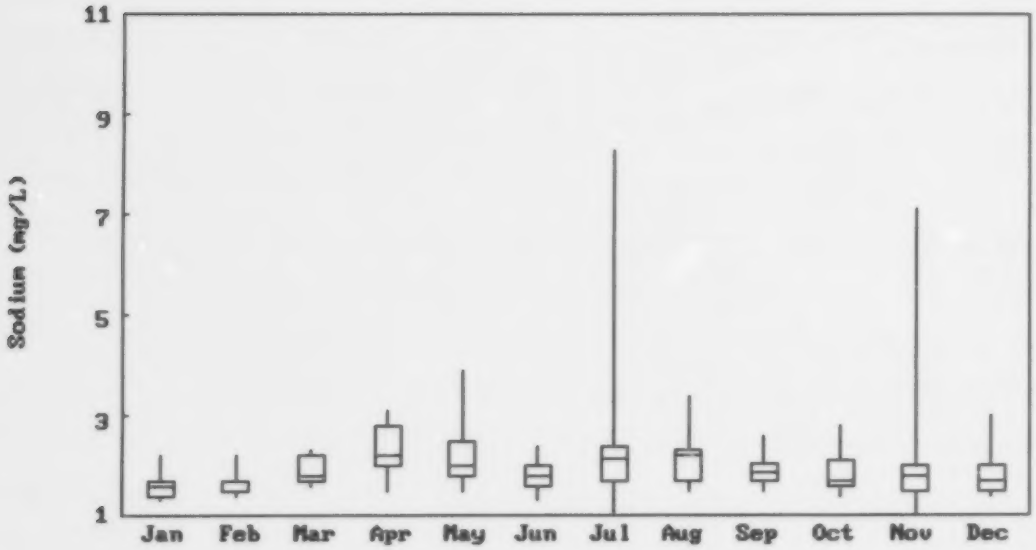
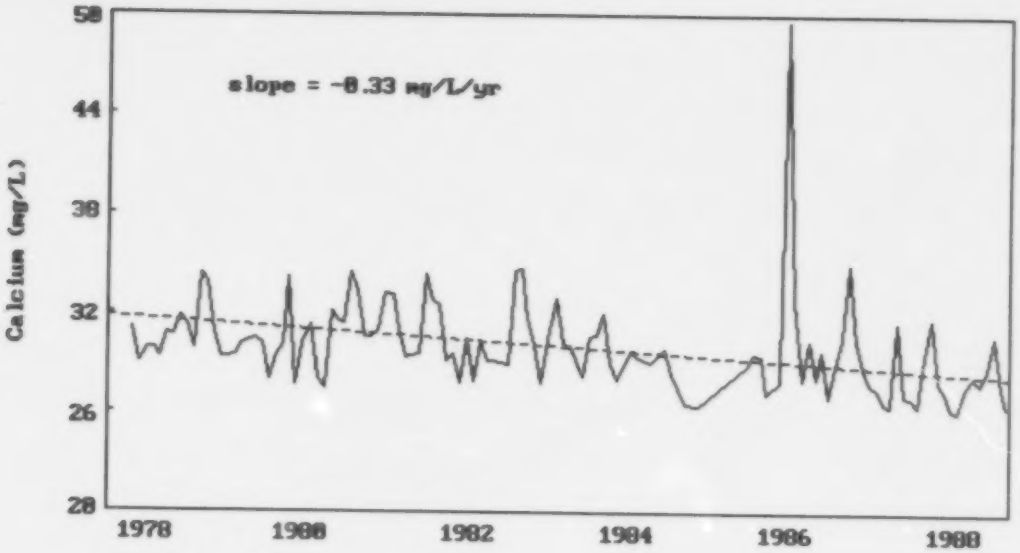


Fig. 21. Seasonal trends in sulphate and sodium concentrations in the Peace River at Dunvegan.



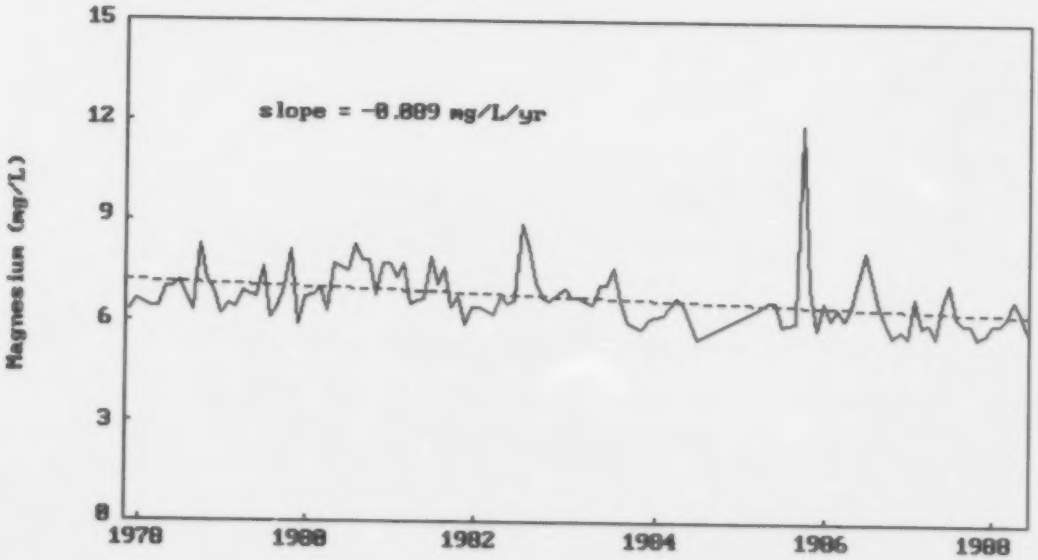


Fig. 22. Long-term trends in calcium and magnesium concentrations in the Peace River at Dunvegan.

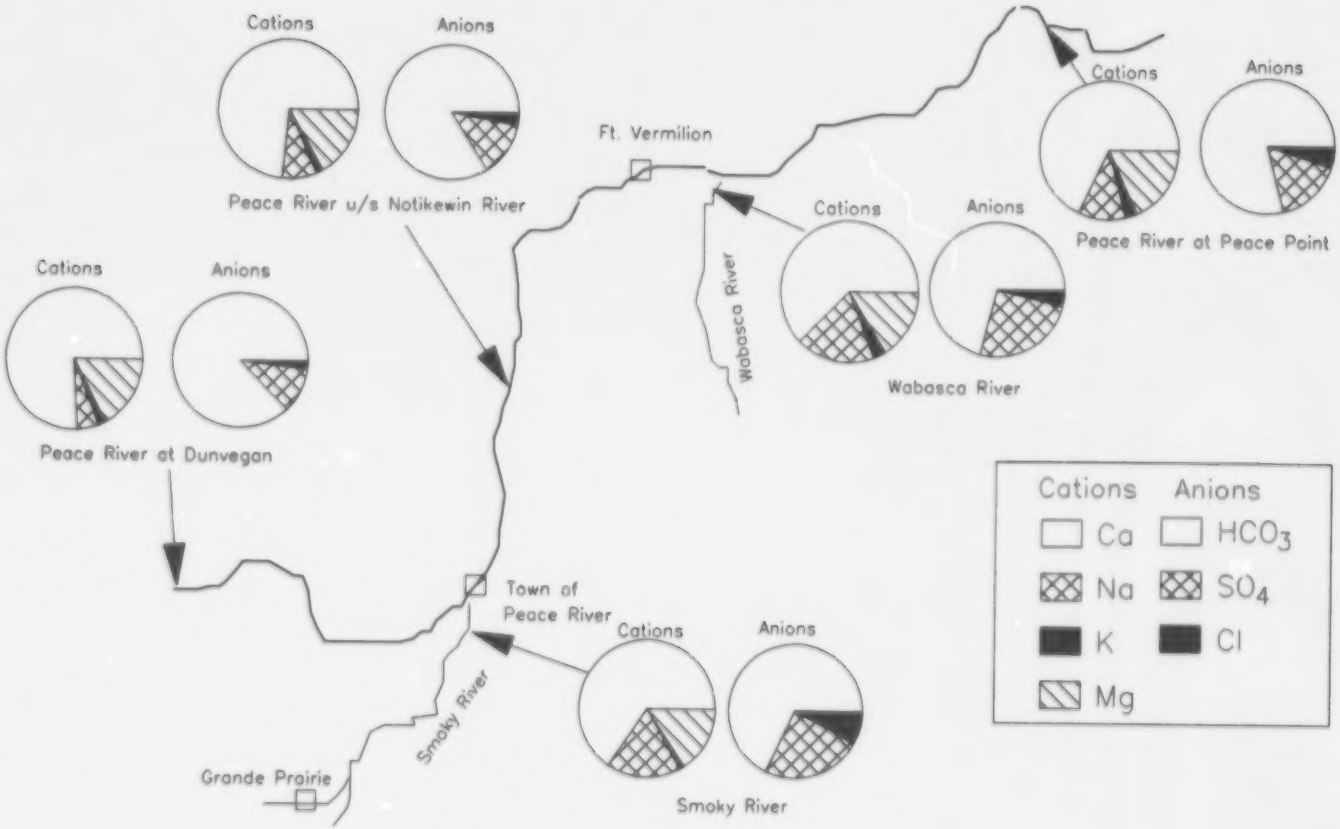


Fig. 23. Major ion composition (% meq/L) in the Peace River system, 1988–89.

lower reaches of the Peace River (Fig. 23).

In 1988-89, average concentrations of the major ions tended to increase from the B.C.-Alberta border to the mouth of the river (Fig. 24,25). The increase along the mainstem was partly a result of tributary loading, particularly from the Smoky River (Table 9). In the tributaries, average concentrations of major ions were higher than in the mainstem (Fig. 26,27), and the highest concentrations were generally recorded during winter low flow conditions. In addition, desorption from particulate matter may contribute to the increased major ion concentrations in the lower reaches of the mainstem. Discharge from the Procter and Gamble pulp mill and Peace River Oils #1 well also contributes a relatively high load of sodium and chloride to the mainstem (Table 9), although the former is included in the Smoky River inflow.

In 1988-89, hardness increased slightly along the mainstem from approximately 100 mg/L at the B.C.-Alberta border to 108 mg/L near Peace Point (Appendix V). Water in the Peace River is considered to be moderately soft (CCREM 1987). In the tributaries, mean hardness was higher than the mainstem, ranging from 130 to 300 mg/L, and the degree of hardness ranged from hard to very hard (Appendix V).

There are no ASWQO or CWQG for freshwater aquatic life for major ions or hardness. The CWQG for chloride (100-700 mg/L, depending upon the crop) and sodium (site-specific, see CWQG for details) pertain to the use of water for irrigation, which is negligible in the Peace River Basin.

4.3.5 Fluoride

Fluoride is present in trace amounts in soils and rocks and is released naturally to the aquatic environment by geochemical weathering. It is considered to be one of the ions responsible for solubilization of aluminum, barium, iron, and other metals in natural water (CCREM 1987).

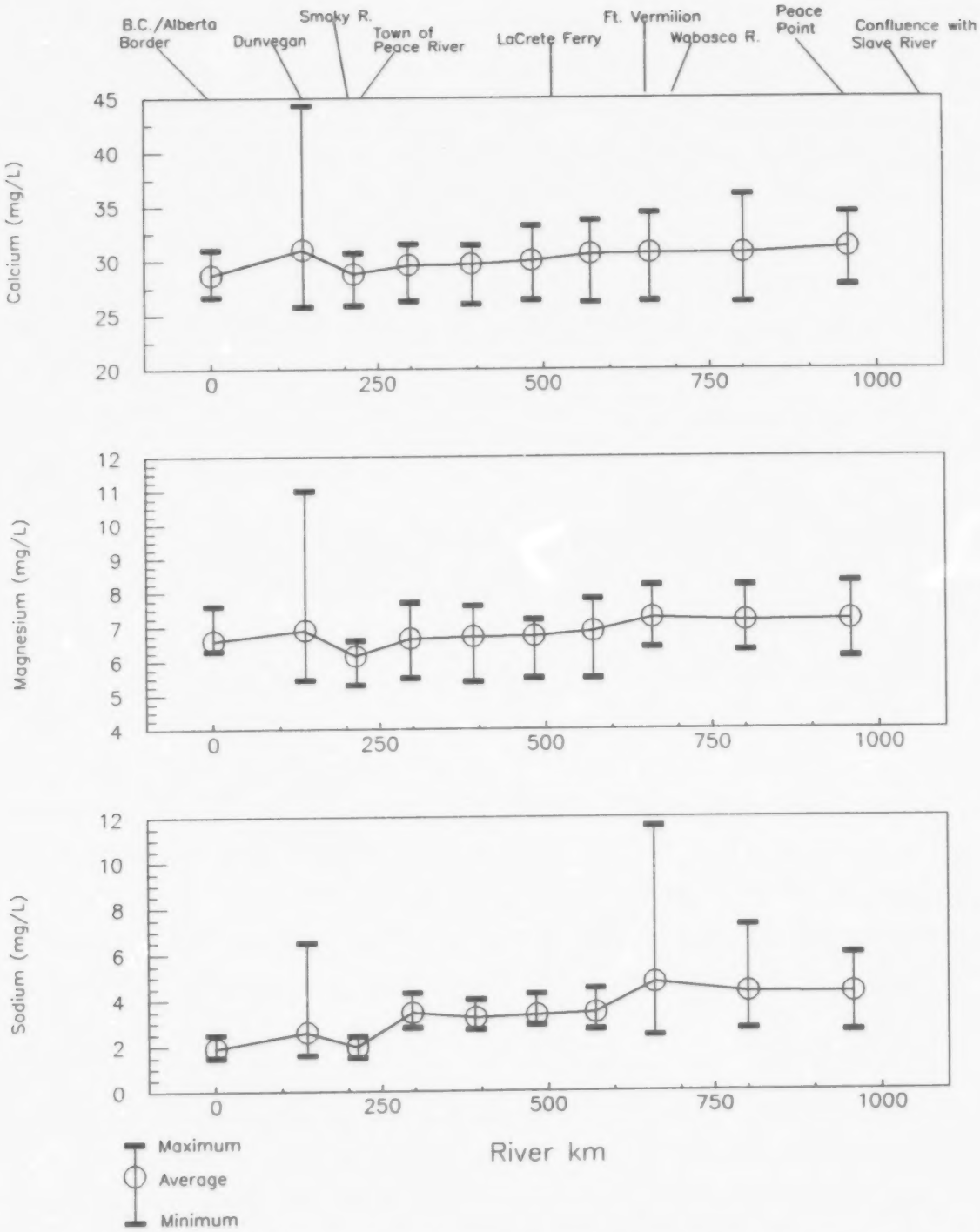


Fig. 24. Calcium, magnesium and sodium in the Peace River, 1988–89.

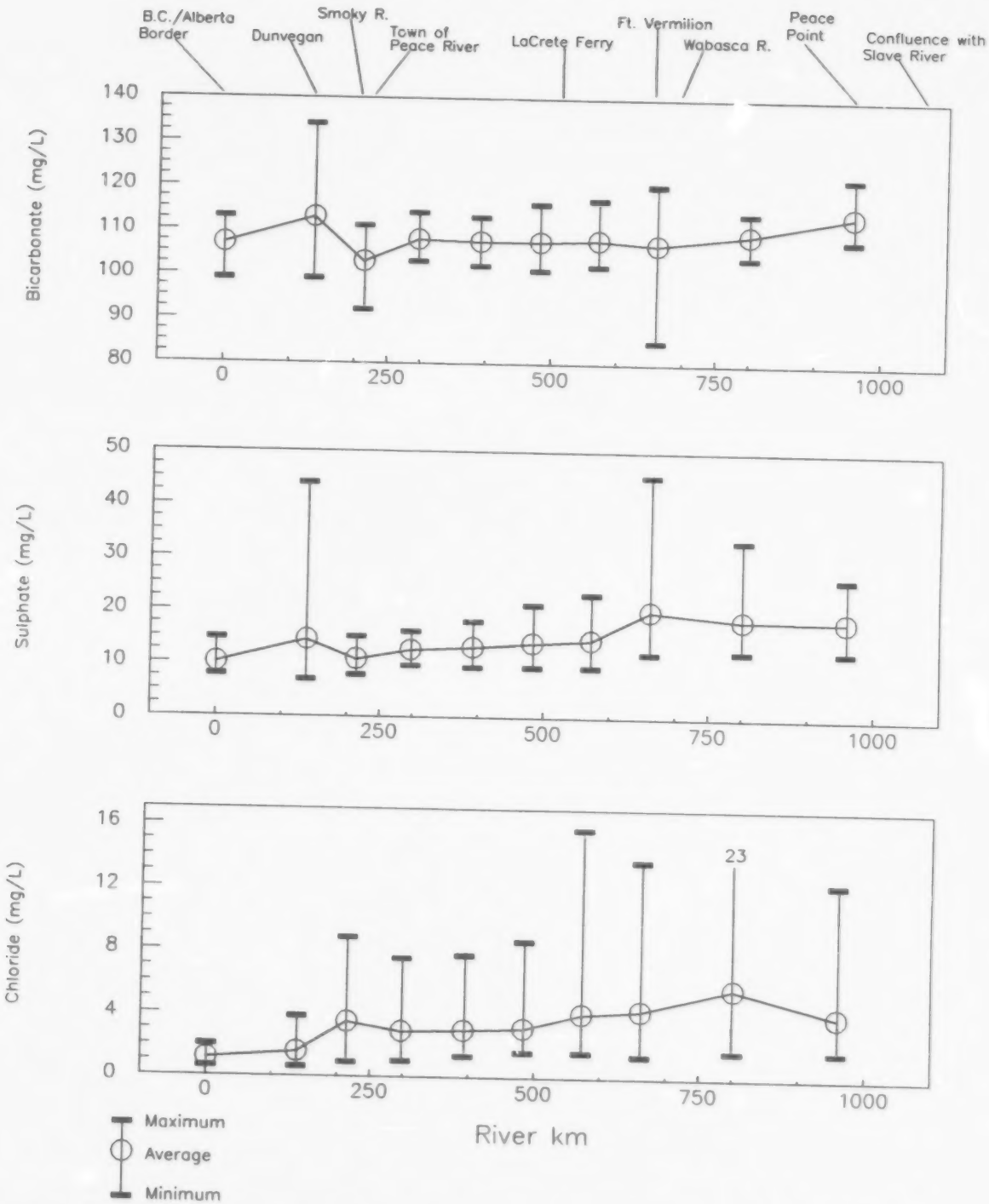


Fig. 25. Bicarbonate, sulphate, and chloride in the Peace River, 1988–89.

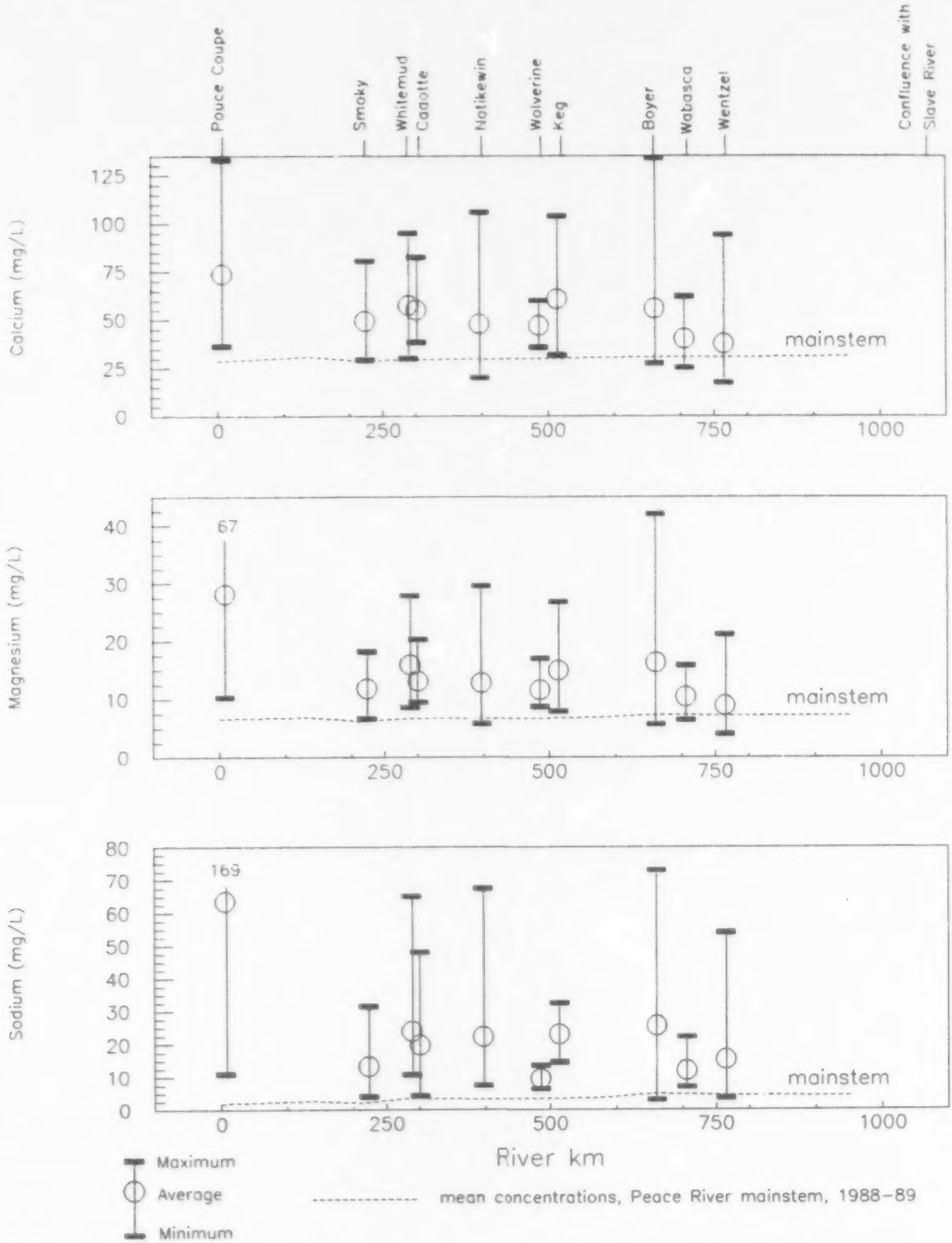


Fig. 26. Calcium, magnesium, and sodium in tributaries to the Peace River, 1988–89.

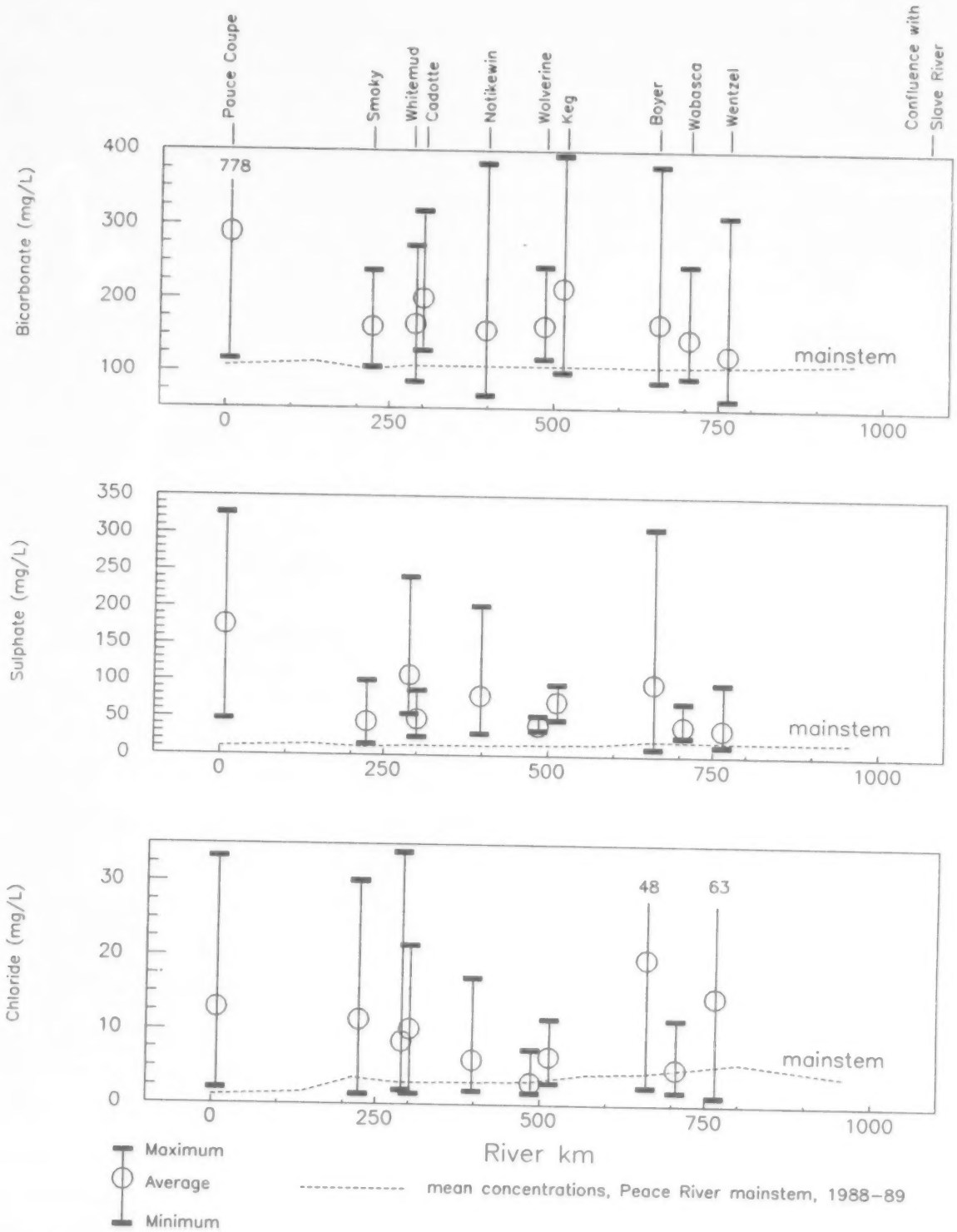


Fig. 27. Bicarbonate, sulphate, and chloride in tributaries to the Peace River, 1988–89.

There were insufficient data from Dunvegan to evaluate the relationship between fluoride and discharge or to assess seasonal and long-term trends. No seasonal pattern in fluoride concentrations was apparent in the synoptic survey data. In 1988-89, fluoride concentrations along the Peace River were relatively constant; average concentrations ranged from 0.053 to 0.084 mg/L (Fig. 28). Average fluoride concentrations in the tributaries were higher than in the mainstem, ranging from 0.086 to 0.188 mg/L (Fig. 28). Both Grande Prairie and Peace River fluoridate their water supply. Even so, fluoride loads from their municipal wastewater are negligible relative to loads in the Peace River (Table 9). The high fluoride concentrations in the tributaries were likely a natural result of drainage from clayey-tills that are rich in illite (Reeder et al. 1972). All historical and survey fluoride concentrations in the Peace River system were well below the CWQG of 1.0 mg/L for irrigation and the ASWQO of 1.5 mg/L.

4.3.6 Dissolved Oxygen and Biochemical Oxygen Demand

Dissolved oxygen (DO) is required by aquatic organisms for aerobic respiration. At low concentrations, it can become a limiting factor for the maintenance of aquatic life. The lower lethal limit is species-specific. The effects of toxins may be magnified if the aquatic organism is under stress due to low dissolved oxygen concentrations (CCREM 1987). Dissolved oxygen concentrations in surface water are affected by photosynthetic activity, biological respiration, temperature, chemical oxidation reactions, and reaeration from the atmosphere. During winter, photosynthetic activity is minimal, and reaeration is greatly limited by ice cover. Bacterial decomposition of organic materials and chemical oxidation of inorganic and organic materials can reduce or totally deplete dissolved oxygen concentrations in rivers in winter. Biochemical oxygen demand (BOD) is a measure of the amount of oxygen required for aerobic microorganisms to oxidize

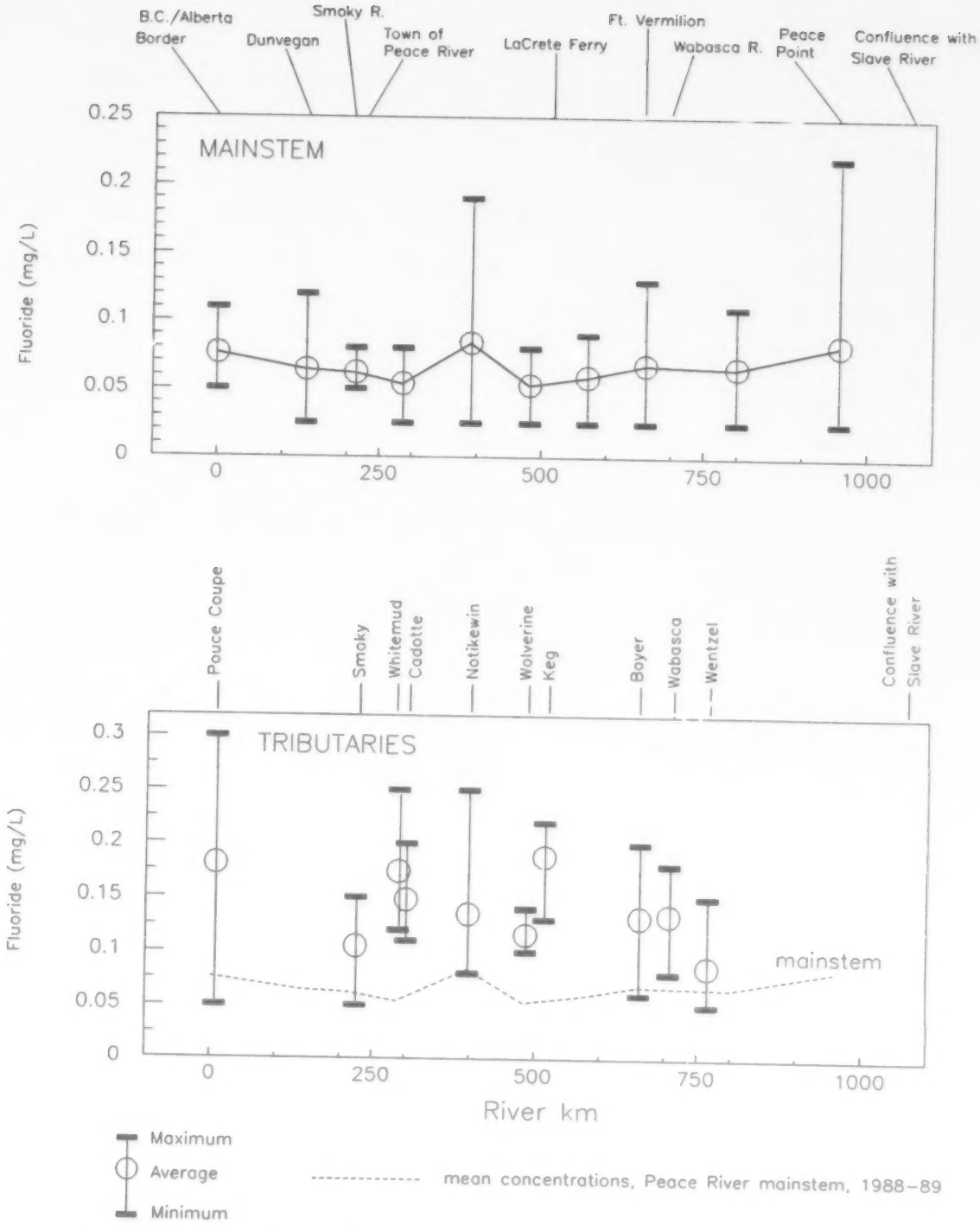


Fig. 28. Fluoride in the Peace River system, 1988-89.

organic matter to a stable inorganic form (CCREM 1987); BOD may also measure the oxygen used to oxidize forms of nitrogen. Biochemical oxygen demand in a water sample is generally measured as the amount of oxygen consumed in laboratory tests over a five-day period at 20 ^{o}C.

Dissolved oxygen concentrations in the Peace River mainstem were independent of discharge (Table 6) and were highest in winter and lowest in summer, reflecting the greater solubility of oxygen with lower water temperatures (Fig. 29). Dissolved oxygen concentrations in many other rivers in Alberta are lowest in winter as a result of low winter flows and greater amounts of oxygen-demanding material compared to the Peace River (Bouthillier and Hrudey 1979). In the Peace River mainstem, DO concentrations remain at or near saturation levels throughout the year. Dissolved oxygen depletion during the winter is minimal in the Peace River because: (1) BOD concentrations are low, (2) the water column is saturated with oxygen as it enters Alberta, (3) reaeration likely occurs at the Vermilion Chutes and perhaps at the Boyer Rapids, and (4) the reach from the B.C. border to the Town of Peace River remains ice-free for much of the winter.

In the Peace River at Dunvegan, DO concentrations increased significantly from 1978 to 1988 (Fig. 29). However, the rate of increase in average annual DO concentrations was low, only 0.07 mg/L/yr. The increase in DO concentrations was not due to changes in solubility since water temperatures did not change during that time period (Table 8). Rather, the change may be a consequence of: (1) a decrease in oxygen-demanding material in the river, (2) relatively mild winters during the 1980s, which would create more extensive ice-free zones upstream of Dunvegan, and/or (3) unrecorded changes in sampling or laboratory procedures.

In 1988-89, average DO concentrations in the Peace River were approximately 11 mg/L near the B.C.-Alberta border and decreased to 10 mg/L near Peace Point (Fig. 30). The decline in DO concentrations was

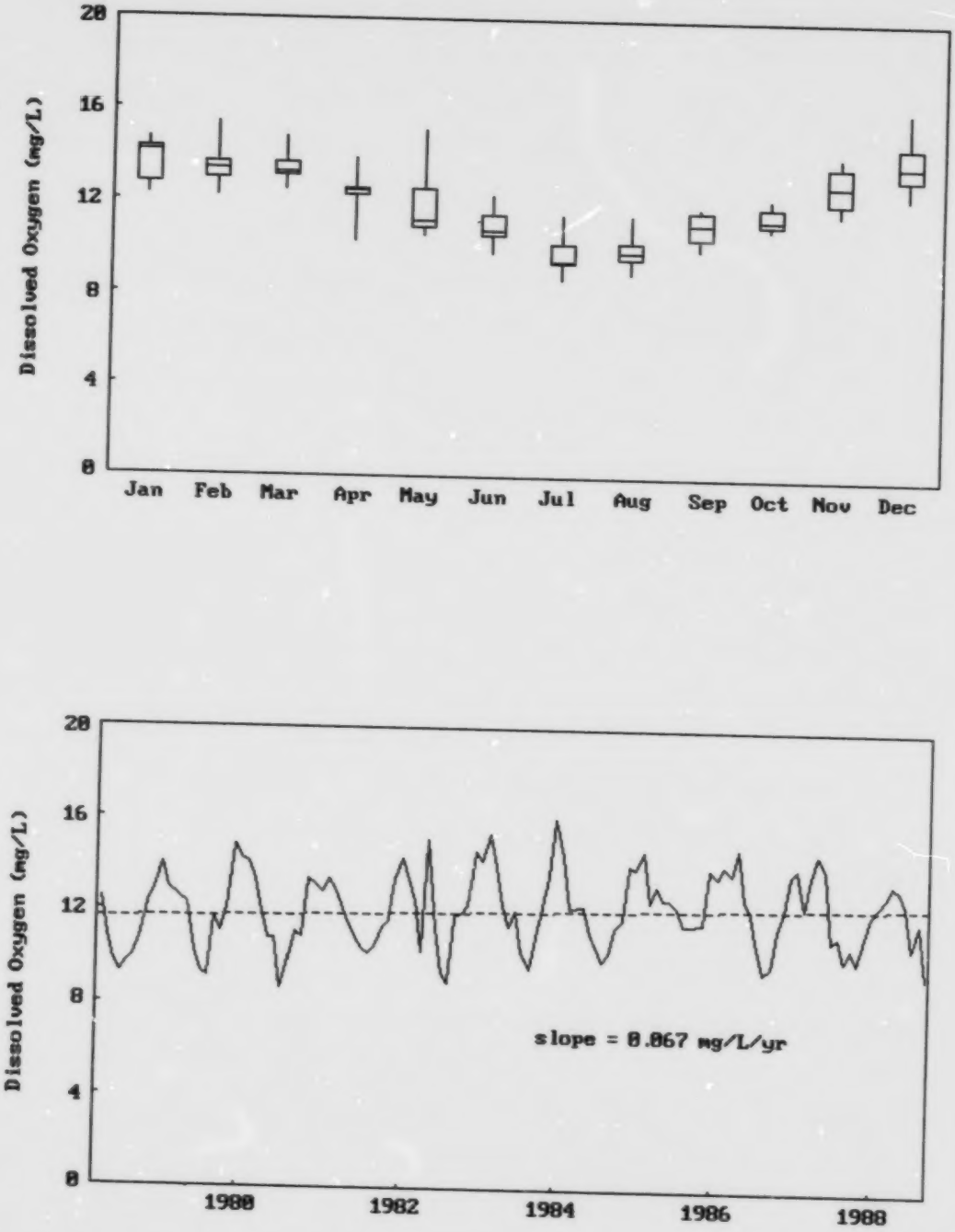


Fig. 29. Seasonal and long-term trends in dissolved oxygen concentrations in the Peace River at Dunvegan.

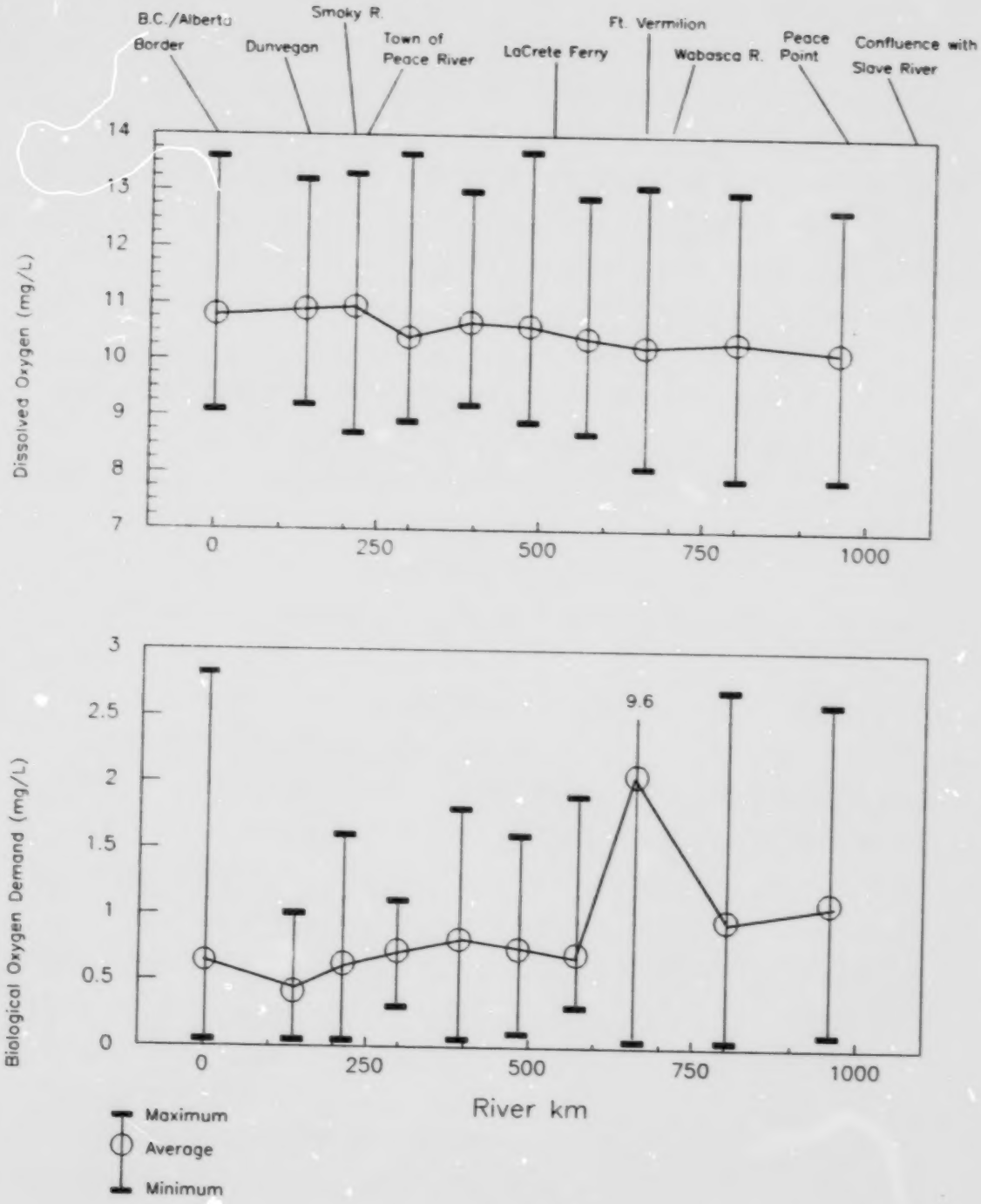


Fig. 30. Dissolved oxygen and biochemical oxygen demand in the Peace River, 1988–1989.

partly a result of increased BOD concentrations, which ranged from approximately 0.3 mg/L near Dunvegan to 1 mg/L near Peace Point (Fig. 30). The average BOD concentration at Ft. Vermilion was skewed by the presence of one high value recorded on 29 September 1988. That sample also contained high concentrations of organic carbon and was highly coloured. The increases in BOD concentrations along the mainstem were a result of natural instream processes, such as degradation of suspended and dissolved organic materials, rather than discharge from tributaries or effluents (Table 9). Suspended solids and organic carbon also increased along the mainstem (Sections 4.3.1 and 4.4.1). In addition, the observed longitudinal pattern in DO concentrations may have been partly a result of the higher water temperatures in the lower reaches of the river (Section 4.2.1), which would decrease the solubility of oxygen in water.

Similar to the Peace River mainstem, dissolved oxygen concentrations in some of the tributaries remained near saturation levels throughout 1988-89, and concentrations were highest in Feb. -March 1989 (Appendix V; Fig. 31). Exceptions to that pattern were observed for the Pouce Coupe, Smoky, Wabasca, and Wentzel rivers, which had low DO concentrations in late winter. Average BOD concentrations in the tributaries were similar to or slightly higher than in the mainstem (Fig. 31).

All historical and survey DO concentrations from the Peace River mainstem complied with the ASWQO of 5 mg/L. However, one sample collected from the Pouce Coupe River in February 1989 was non-compliant with that objective. The CWQG are for warm- and cold-water fish, both of which occur in the Peace River system (Paetz 1984). The guideline for warm-water biota are 6 and 5 mg/L for early and late life stages, respectively. With the exception of the one sample from the Pouce Coupe River and a sample from the Wabasca River in early March 1989, all mainstem sites and tributaries complied with the guidelines. For cold-

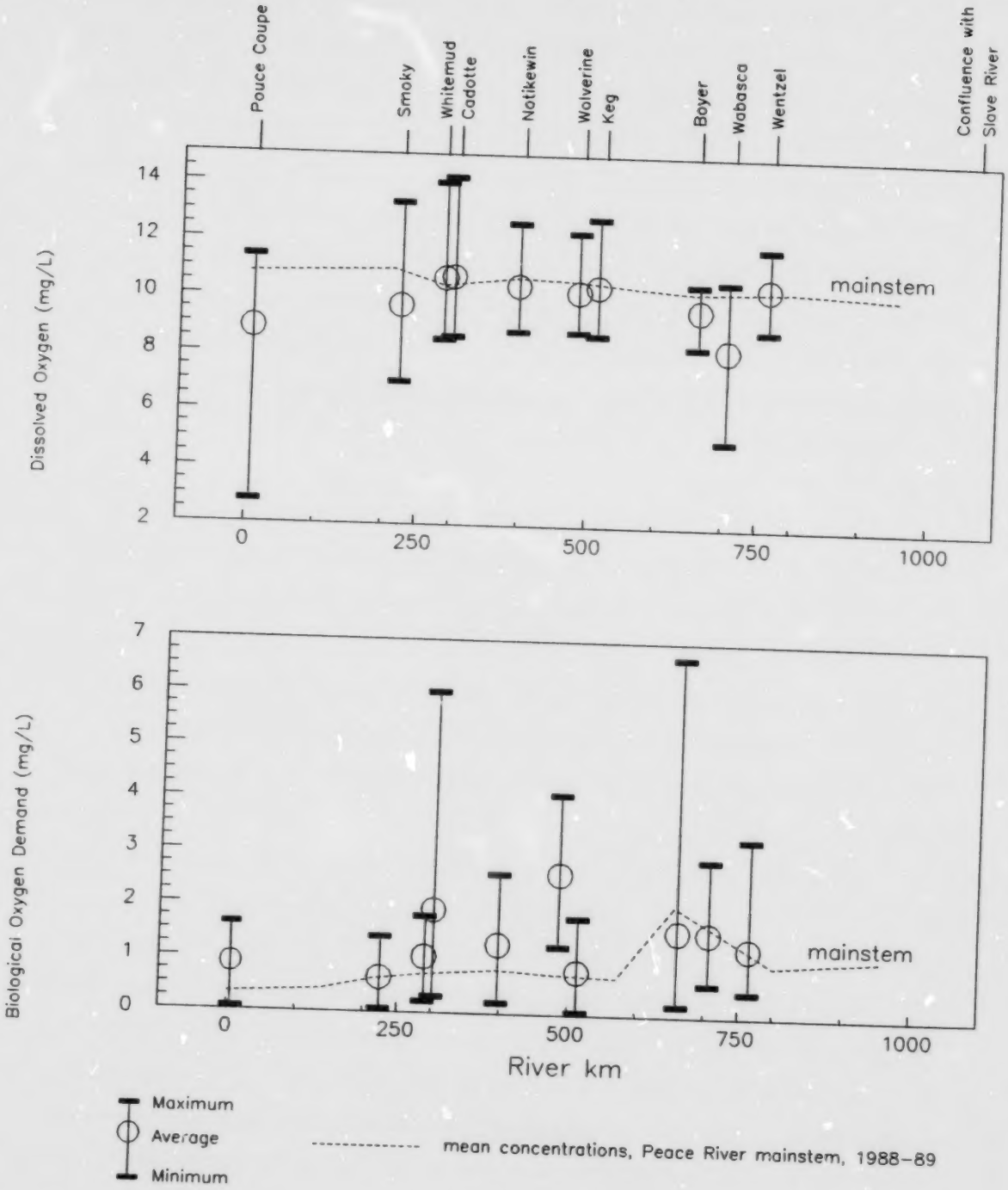


Fig. 31. Dissolved oxygen and biochemical oxygen demand in tributaries to the Peace River, 1988–89.

water biota, the CWQG are 9.5 and 6.5 mg/L for early and other life stages, respectively. With the exception of the above mentioned tributaries, all sites complied with the 6.5 mg/L guideline. However, most sites along the mainstem and tributaries were non-compliant with the 9.5 mg/L guideline during the summer months, but this was likely a natural result of lower oxygen solubility associated with higher water temperatures. There are no CWQG for BOD, and the ASWQO for BOD is that it does not create a DO concentration of $\leq$ 5 mg/L. All data from the Peace River mainstem complied with that objective.

4.3.7 Metals

4.3.7.1 General

Metals in water exist in a number of soluble (e.g., free metal ions, associated with colloids) and particulate forms (e.g., associated with clays, organic matter). Concerns over metals relate to their toxicity and the potential for bioaccumulation and hazards to human health (CCREM 1987). pH plays a major role in the chemical speciation, water solubility, and bioavailability of many metals. At high pH, metals form hydroxides or carbonates, which are relatively insoluble and usually precipitate. At low pH, the solubility of metals in waters increases.

In the Peace River system, a number of metals have been analyzed for dissolved, extractable and/or total fractions. For most metals, there were too few historical data or too many censored data to test the relationship between metal concentrations and discharge. Of the metals that were tested for flow-dependency, concentrations of dissolved boron and arsenic were independent of flow and extractable iron and manganese increased significantly with flow (Table 6). In 1988-89, concentrations of most total metals (aluminum, arsenic, barium, copper, iron, manganese, nickel, and zinc) were highly correlated to suspended solids

(r = 0.70 to 0.90; df = 151; P < 0.001). Compared to these metals, total boron was weakly correlated to suspended solids (r = 0.28; df = 151; P < 0.001). There were too many censored data to evaluate the other metals. Since suspended solids concentrations increased with flow (Table 6), concentrations of most total metals would also likely be flow-dependent. Similarly, concentrations of total metals would likely follow the seasonal pattern for suspended solids of peaks in late spring and early summer and lows in late fall and winter (Fig. 15). Concentrations of total metals recorded during the synoptic surveys were consistent with this pattern (Appendix V).

Concentrations of dissolved metals during the synoptic surveys followed no consistent seasonal patterns (Appendix V). There were, however, significant seasonal differences in concentrations of extractable manganese and extractable iron in the mainstem at Dunvegan (Fig. 32). For these constituents, concentrations of both actual and flow-adjusted concentrations were highest in April-June and lowest in January-March, roughly following the pattern observed for suspended solids (Fig. 15).

For most metals, there were insufficient historical data to test for long-term trends. However, no long-term trends in total metal concentrations would be likely since suspended solid concentrations did not change significantly from 1978 to 1987 (Table 8). In addition, the dissolved fraction of boron and the extractable fractions of iron and manganese showed no significant long-term trends (Table 8).

4.3.7.2 Aluminum

Aluminosilicate minerals are abundant in all rocks and geological materials, especially clay. Aluminum can be mobilized from soils and sediments by natural weathering and in response to acidification (CCREM 1987). Concentrations of aluminum and iron were the highest of any of the metals measured in the 1988-89 synoptic surveys. Average total

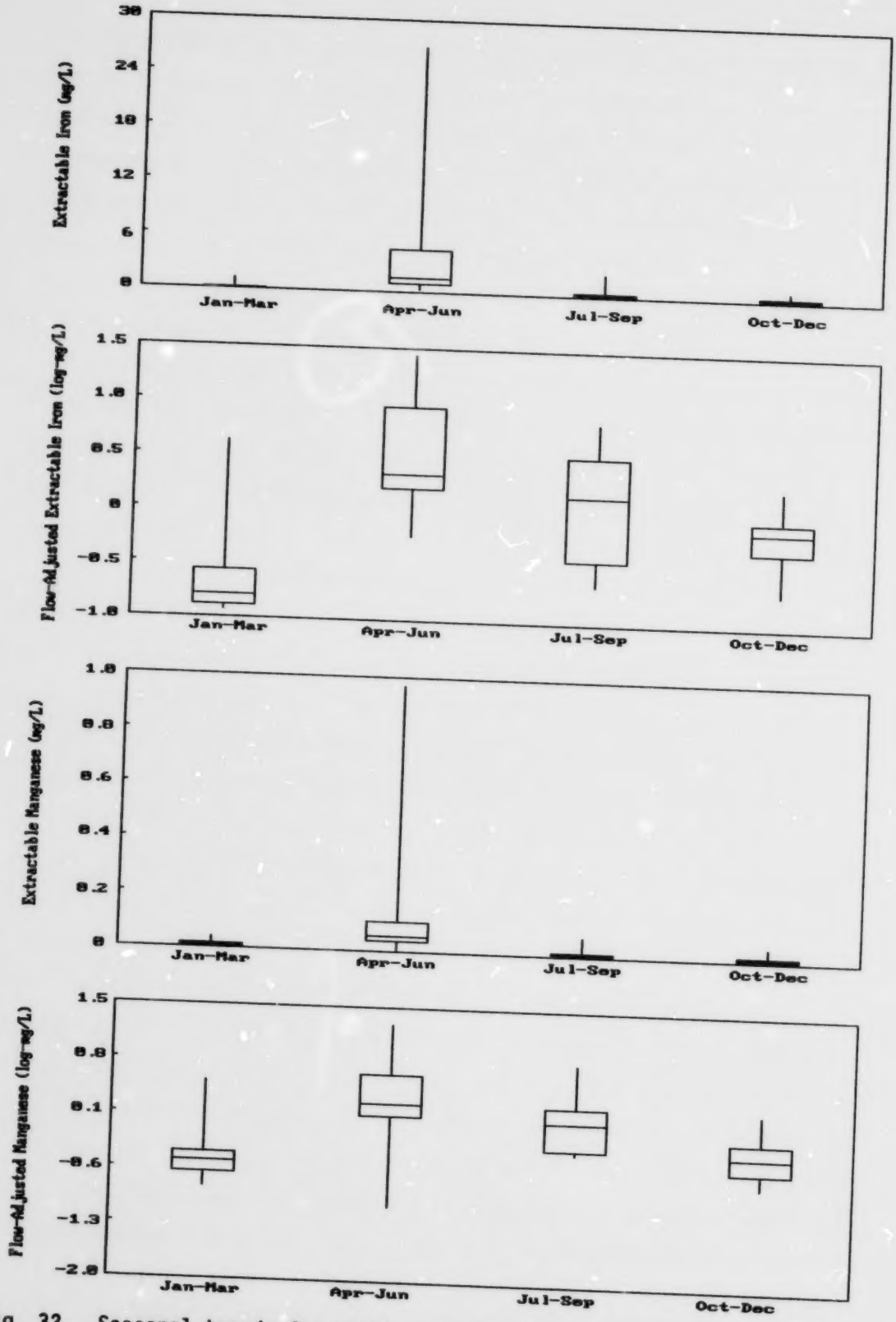


Fig. 32. Seasonal trends for metal concentrations in the Peace River at Dunvegan.

aluminum concentrations in the Peace River mainstem were relatively low near the B.C.-Alberta border, 0.5 mg/L, but increased to nearly 10 mg/L in the lower reach of the river (Fig. 33). The high aluminum concentrations were a result of the high suspended solids concentrations and increased predominance of fine-grained suspended solids in the lower reaches of the mainstem, rather than loading from tributaries or effluents (Table 9). Average total aluminum concentrations in the tributaries were similar to the mainstem (Fig. 34). During the 1988-89 synoptic surveys, most aluminum was in the particulate fraction; on average, dissolved aluminum accounted for only 13 percent of the total (Appendix V). The longitudinal pattern for dissolved aluminum was similar to that for total aluminum. Average concentrations of dissolved aluminum in the Peace River were 0.02 mg/L near the B.C.-Alberta border and increased to 0.06 mg/L at Peace Point (Appendix V). In the tributaries, average concentrations of dissolved aluminum ranged from 0.01 mg/L in the Smoky River to 0.033 mg/L in the Boyer River. In general, concentrations were highest in the brownwater streams, likely as a result of surface runoff from peatlands (Turchenek et al. 1987).

There is no ASWQO for aluminum. The CWQG for freshwater aquatic life is 0.1 mg/L aluminum for the range of pH, calcium, and dissolved organic carbon levels found in surface waters in the Peace River Basin. Most historical and survey data for surface waters in the Peace River Basin were non-compliant with that guideline. However, the high aluminum levels in the Peace River are likely a consequence of high suspended solids loads and the high clay content of the suspended solids, since aluminum is found predominantly in the clay fraction of sedimentary rocks (Havas and Jaworski 1985). Aluminum is generally most toxic to aquatic biota at low pH (< 6) and the ionic form is generally considered to be more toxic than particulate aluminum (CCREM 1987). In addition, fluoride, calcium, and humic acids reduce the availability of aluminum to aquatic biota (Havas and Jaworski 1985). Thus, the high

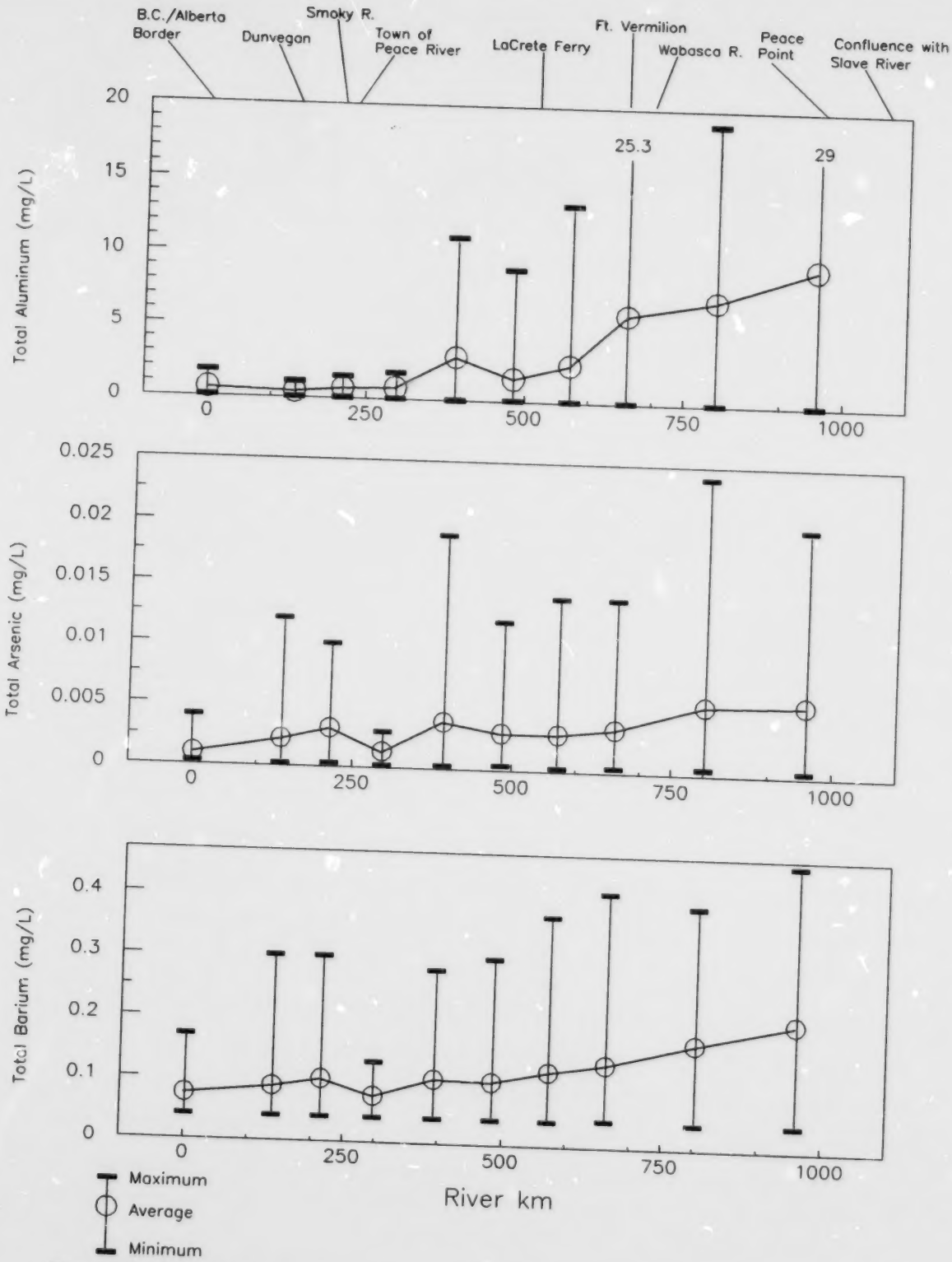


Fig. 33. Aluminum, arsenic, and barium concentrations in the Peace River, 1988–89.

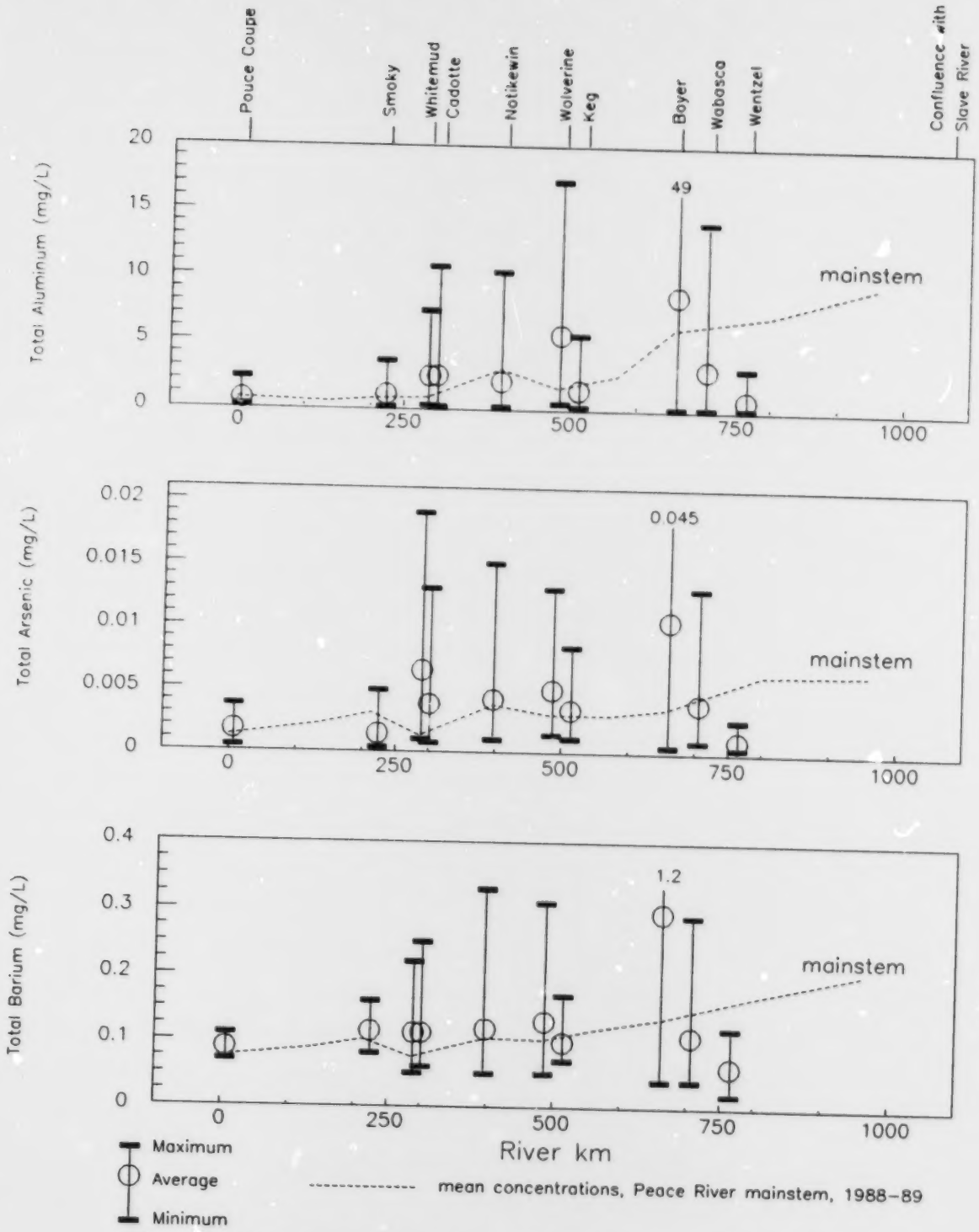


Fig. 34. Aluminum, arsenic, and barium concentrations in tributaries to the Peace River, 1988–89.

aluminum concentrations in the Peace River system likely have little toxic effect and are not of concern.

4.3.7.3 Antimony

Antimony is generally found in trace amounts in surface waters as a result of geochemical weathering of rocks and runoff from soils (CCREM 1987). Antimony was not measured in the 1988-89 synoptic surveys and historical data are limited to samples collected in the early 1970s. Concentrations of extractable antimony in the historical data set range from below the detection limit (which varied from 0.008 to 0.5 mg/L) to a high of 0.065 mg/L in the mainstem and from below detection to 0.2 mg/L in the tributaries. These concentrations are within the range reported for other surface waters in western Canada (CCREM 1987). There are no CWQG or ASWQO for antimony.

4.3.7.4 Arsenic

Arsenic is released naturally into the aquatic environment as a result of geochemical weathering of rocks (CCREM 1987). In 1988-89, total arsenic concentrations in the Peace River and its tributaries were low, generally less than 0.005 mg/L, although they increased slightly in the lower reaches of the mainstem (Fig. 33, 34). On average, 38 % of total arsenic was in the dissolved fraction (Appendix V). All surface waters that have been sampled to date in the Peace River system complied with the CWQG for freshwater aquatic life of 0.05 mg/L. However, many samples from both the mainstem and tributaries exceeded the ASWQO of 0.01 mg/L total arsenic. All dissolved arsenic concentrations were less than 0.01 mg/L. The high concentrations for total arsenic were likely a result of the high suspended solid content of the waters, rather than discharge from effluents (Table 9).

4.3.7.5 Barium

Barium is a common element in the earth's crust, although only trace levels are normally found in surface water (CCREM 1987). In 1988-89, mean concentrations of total barium increased from approximately 0.08 mg/L at the B.C.-Alberta border to 0.2 mg/L near Peace Point (Fig. 33). Mean concentrations in the tributaries were similar to the mainstem (Fig. 34). In contrast to aluminum and arsenic, the dissolved fraction comprised a considerable portion (76 %) of total barium in the Peace River system (Appendix V). With the exception of one sample from the Boyer River (when the suspended solids concentrations were also high - 5 May 1988) all surface waters in the Peace River Basin have complied with the ASWQO of 1.0 mg/L. There are no CWQG for barium.

4.3.7.6 Beryllium

The major source of beryllium in the environment is from the combustion of fossil fuels (CCREM 1987). In nearly all surface waters and effluents sampled in the Peace River system in 1988-89, total and dissolved beryllium concentrations were less than the detection limit of 0.001 mg/L. The highest concentration recorded in the synoptic surveys was 0.002 mg/L. There are no CWQG or ASWQO for beryllium.

4.3.7.7 Boron

Boron is released naturally into the aquatic environment from geochemical weathering and soil leaching (CCREM 1987). In 1988-89, mean total boron concentrations increased from 0.04 mg/L near the B.C.-Alberta border to 0.08 mg/L in the lower reach of the river (Fig. 35). In general, mean concentrations in the tributaries were higher than the mainstem (Fig. 36). Like barium, the dissolved fraction comprised a substantial portion (76 %) of total boron in the Peace River system. The ASWQO for boron is 0.5 mg/L and the most stringent CWQG for boron

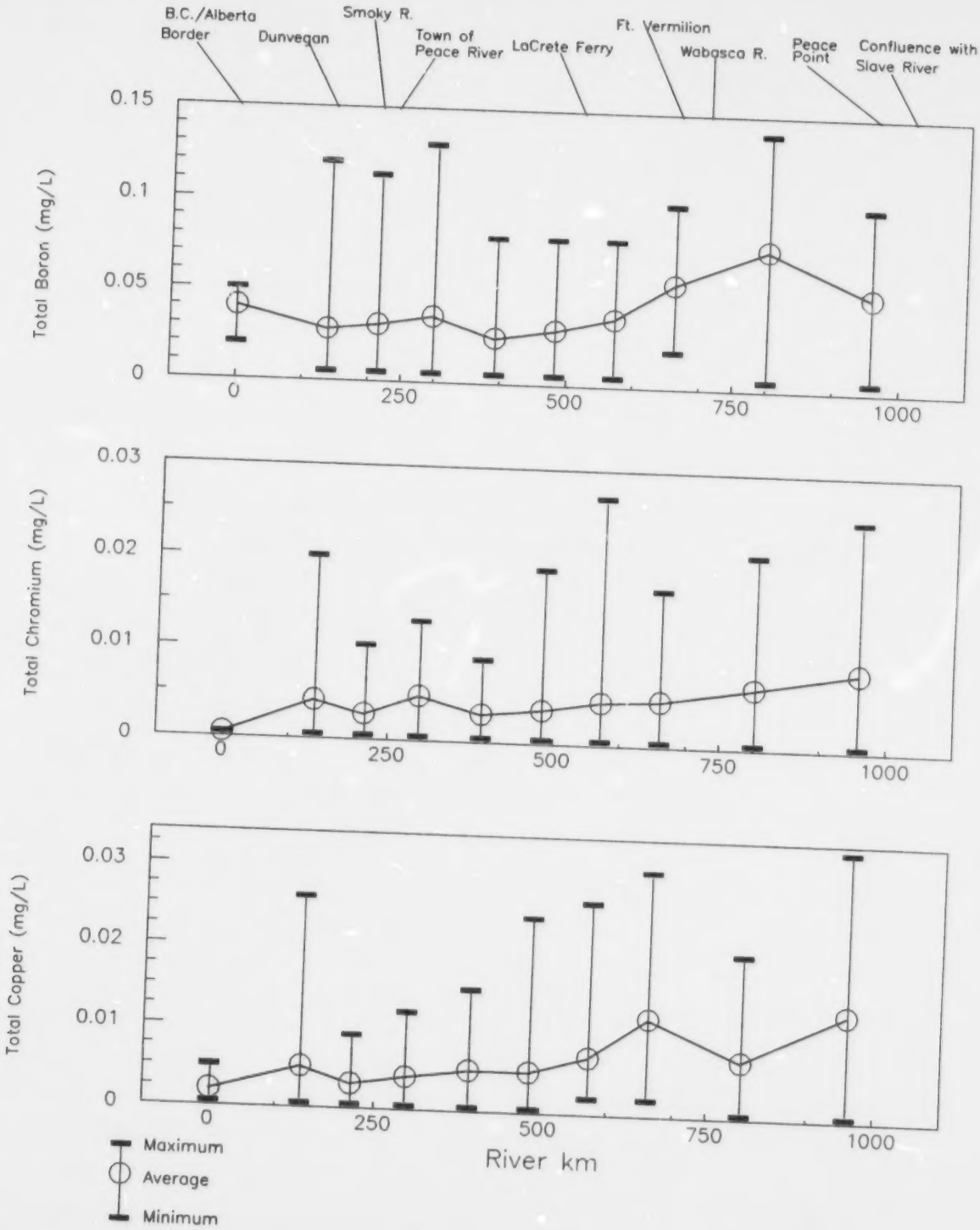


Fig. 35. Boron, chromium, and copper concentrations in the Peace River, 1988–89.

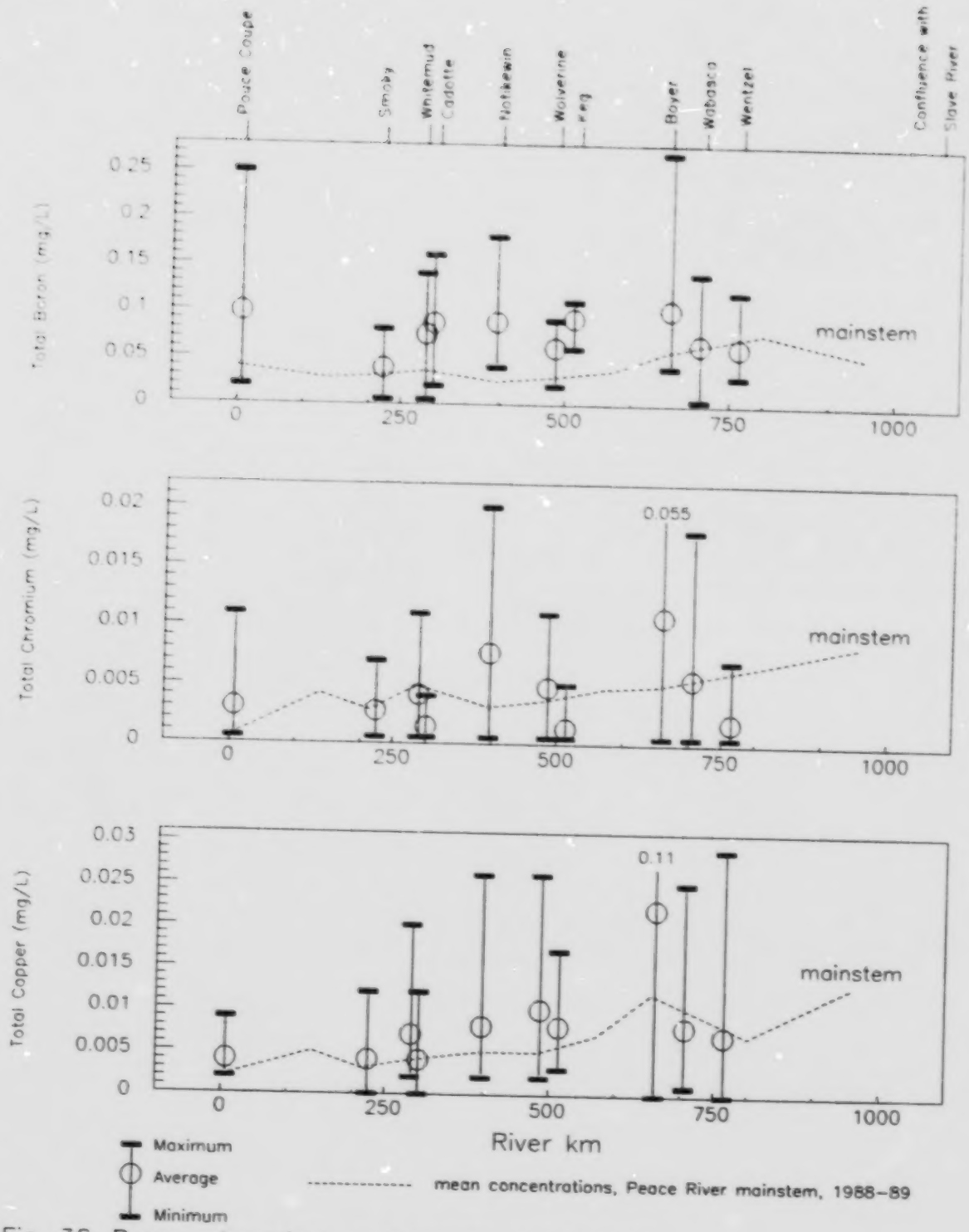


Fig. 36. Boron, chromium, and copper concentrations in tributaries to the Peace River, 1988–89.

pertains to irrigation water (0.5-6.0 mg/L, depending upon the crop). All 1988-89 survey data complied with these guidelines and objectives. However, historically the 0.5 mg/L objective has been exceeded twice - one sample was from the mainstem at Dunvegan (11 Feb. 1985: 0.6 mg/L) and the other from the Smoky River at Watino (15 May 1984: 2.7 mg/L).

4.3.7.8 Cadmium

Cadmium is present in trace concentrations in fresh water as a result of natural weathering phenomena. Concentrations above approximately 0.01 mg/L can usually be attributed to anthropogenic sources such as emissions from mining, agriculture, and the burning of fossil fuels (CCREM 1987). During the 1988-89 surveys, total cadmium was detected at trace amounts in some samples (maximum 0.004 mg/L) from the mainstem and tributaries, but it was below the detection limit of 0.001 mg/L in most samples. The ASWQO for cadmium is 0.01 mg/L. The CWQG for freshwater aquatic life varies with the water's hardness. For hardness levels typical of the Peace River (80-120 mg/L) the guideline is 0.0008 mg/L, which is below the analytical detection limit of 0.001 mg/L. All historical and survey data for the Peace River system complied with the ASWQO of 0.01 mg/L, although a number of samples from both the mainstem and tributaries were non-compliant with the CWQG of 0.0008 mg/L. Effluent loads of cadmium were low (Table 9), and the relatively high concentrations appears to result from natural processes.

4.3.7.9 Chromium

Weathering is the main process by which chromium is released naturally into the environment. In 1988-89, mean total chromium concentrations along the mainstem increased from below the detection limit of 0.001 mg/L at the B.C.-Alberta border to 0.008 mg/L at Peace Point (Fig. 35). Dissolved chromium concentrations were generally less than 0.001 mg/L. Average total chromium concentrations in the

tributaries were similar to those in the mainstem (Fig. 36). A few samples collected in 1988-89 from the lower reach of the mainstem and the Boyer River were non-compliant with the CWQG to protect fish (0.02 mg/L chromium). In addition, the Boyer River sample was also non-compliant with the ASWQO of 0.05 mg/L. For the historical data, one sample from the mainstem at Dunvegan and two from the Smoky River at Watino were non-compliant with the ASWQO. However, the high chromium levels were a result of the high suspended solid content of the water rather than discharge of effluents (Table 9).

4.3.7.10 Cobalt

The amount of cobalt in surface waters is generally very small (CCREM 1987). At most mainstem sites and tributaries sampled in 1988-89, total cobalt concentrations were below the detection limit of 0.001 mg/L. The maximum concentration in the mainstem was from Peace Point (0.012 mg/L) and in the tributaries was from the Boyer River (0.028 mg/L). These two high values occurred when suspended solids concentrations were also high. There are no ASWQO or CWQG for cobalt.

4.3.7.11 Copper

Natural sources of copper to aquatic environments include the weathering of copper minerals and native copper (CCREM 1987). Background concentrations are usually below 0.02 mg/L; higher concentrations are generally related to anthropogenic sources. Like most of the metals, mean total copper concentrations increased along the mainstem, from 0.002 mg/L at the B.C.-Alberta border to 0.013 mg/L at Peace Point (Fig. 35). Concentrations of dissolved copper were, on average, 25 % of total copper. Average total copper concentrations in the tributaries tended to be slightly higher than in the mainstem (Fig. 36). The higher total copper concentrations in the lower reaches of the

mainstem were largely a result of the increased suspended solids concentrations. In 1988-89, samples from a number of sites in the mainstem and several of the tributaries were non-compliant with the ASWQO of 0.02 mg/L for total copper, and all mainstem sites and tributaries were non-compliant with the CWQG for freshwater aquatic life of 0.002 mg/L total copper. Most historical data were non-compliant with the CWQG. However, these relatively high copper concentrations were probably related to natural processes because effluent loads of copper were low (Table 9).

4.3.7.12 Iron

Iron is released naturally into the aquatic environment from weathering of sulphide ores and rocks and leaching from sandstones (CCREM 1987). In 1988-89, mean total iron concentrations in the Peace River were high, ranging from approximately 2 mg/L at the B.C.-Alberta border to 10 mg/L in the lower reach of the river (Fig. 37). Mean total iron concentrations in the tributaries were of similar magnitude to the mainstem (Fig. 38). Most of the iron was particulate; on average, 14 % was dissolved. The proportion of dissolved iron increased in the northern tributaries (e.g., Wentzel River: 32 %). Concentrations of dissolved iron were correlated to dissolved organic carbon ($\underline{r}$ = 0.59; df = 151; $\underline{P}$ < 0.001), and these high dissolved iron values were a result of drainage from peatlands, which cover extensive portions of the northern part of the Peace River Basin (Fig. 6). Most historical and survey data from both mainstem and tributaries were non-compliant with the CWQG for freshwater aquatic life and the ASWQO of 0.3 mg/L iron. However, as explained above the high iron concentrations were likely due to natural processes; effluent loads of iron were negligible (Table 9).

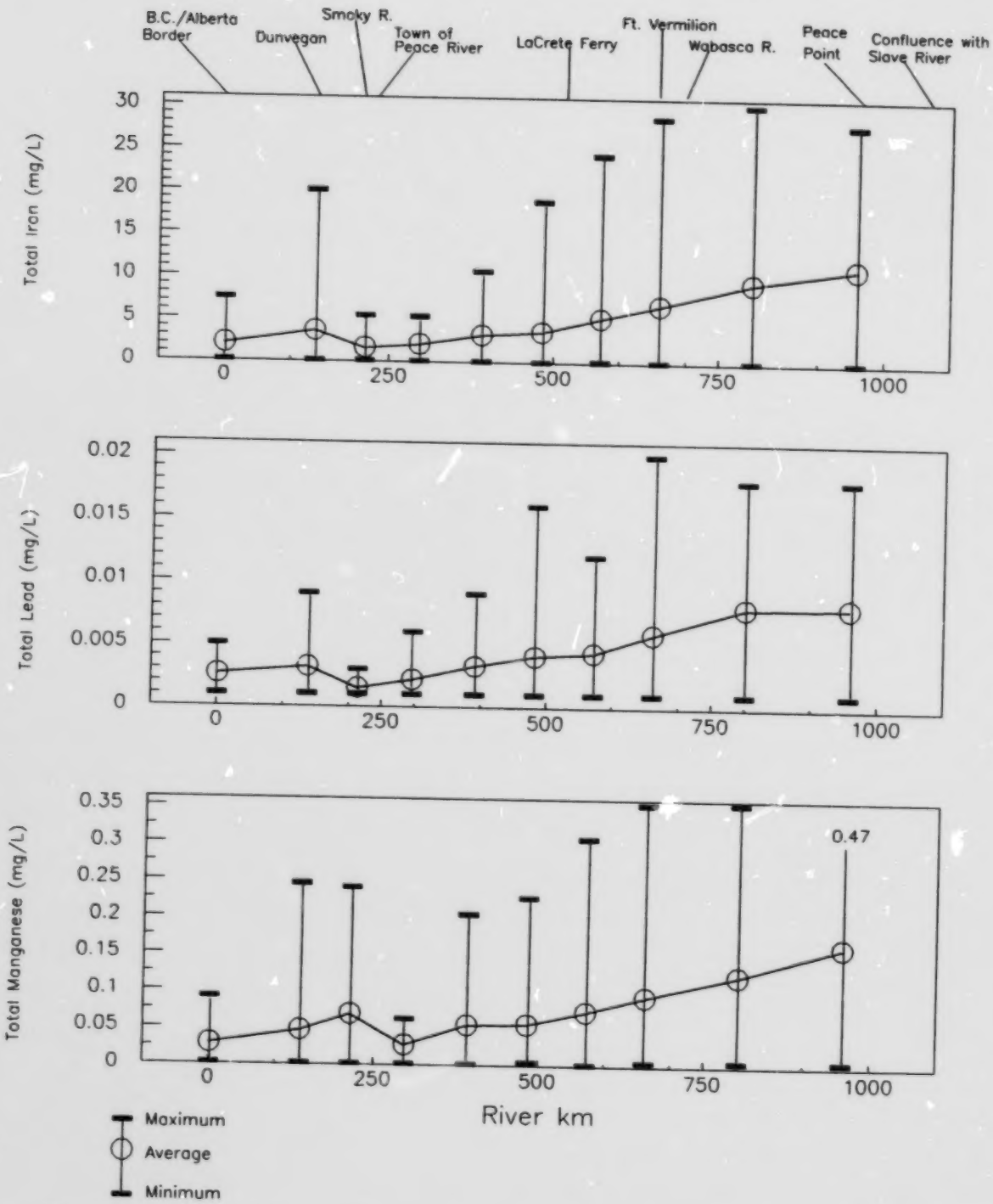


Fig. 37. Iron, lead, and manganese concentrations in the Peace River, 1988–89.

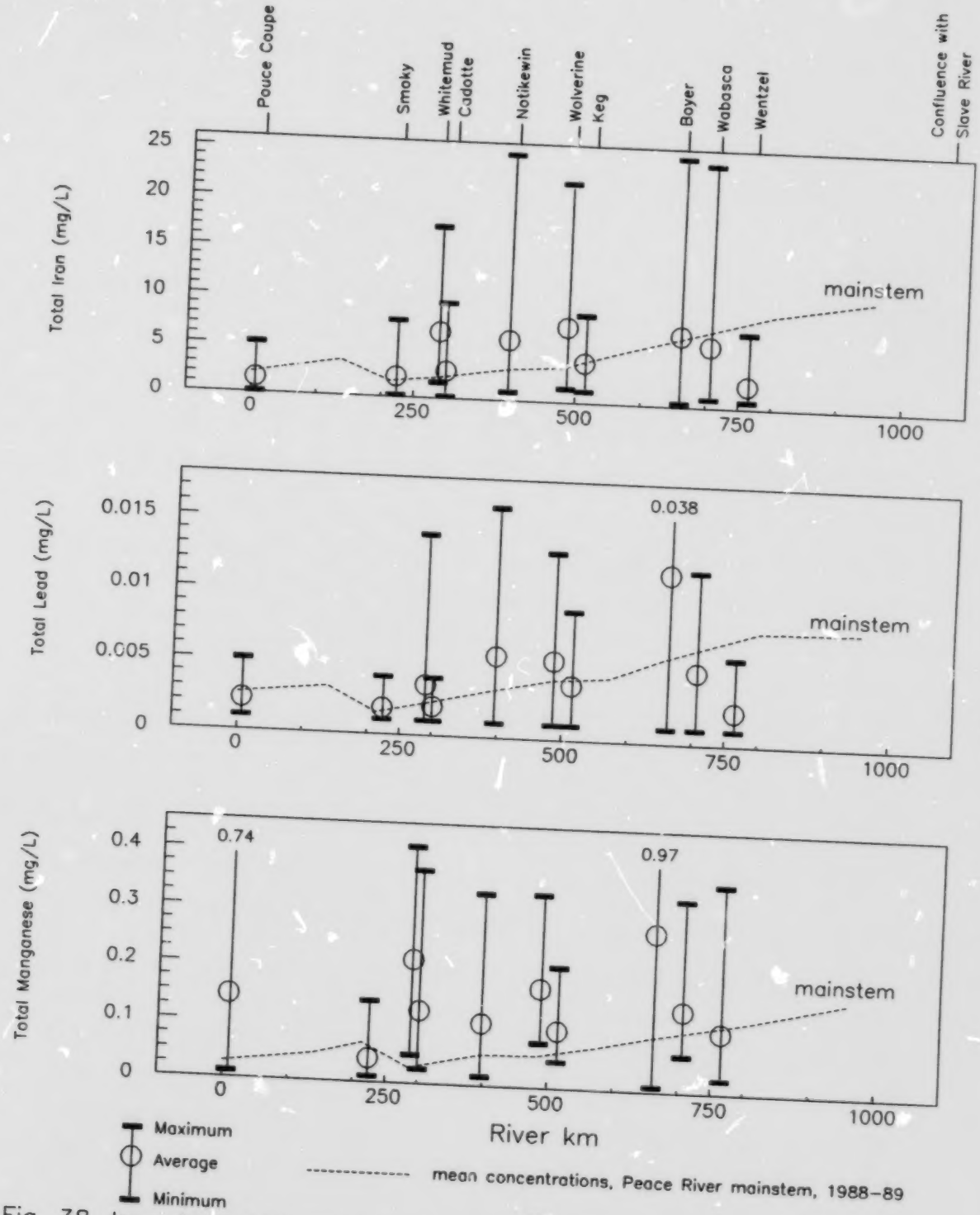


Fig. 38. Iron, lead and manganese concentrations in tributaries to the Peace River, 1988–89.

4.3.7.13 Lead

Concentrations of lead in natural surface waters are generally low. In 1988-89, mean total lead concentrations ranged from 0.002 to 0.008 mg/L in the mainstem (Fig. 37) and from 0.002 to 0.012 mg/L in the tributaries (Fig. 38). These concentrations fall within the range for lead in western Canadian surface waters (CCREM 1987). Dissolved lead was generally below the detection limit of 0.002 mg/L (Appendix V). All historical and survey data from both the mainstem and tributaries complied with the ASWQO of 0.05 mg/L lead, although most were non-compliant with the CWQG for freshwater aquatic life of 0.002 mg/L. None of the effluents had appreciable amounts of lead (Table 9) and the high lead concentrations in the river appear to be due to natural processes.

4.3.7.14 Lithium

Lithium is easily leached from rocks and sediments and usually occurs with sodium in aqueous solutions (CCREM 1987). Lithium was not measured in the synoptic surveys, although there are historical data. Extractable lithium concentrations in the Peace River mainstem have ranged from below the detection limit of 0.005 mg/L to 0.067 mg/L. Concentrations in the tributaries were similar to the mainstem, ranging from less than 0.005 to 0.081 mg/L. Lithium concentrations in these surface waters are probably controlled by the weathering of Cretaceous shales (Reeder et al. 1972). There are no ASWQO or CWQG for lithium.

4.3.7.15 Manganese

Soils, sediments, and metamorphic and sedimentary rocks are significant natural sources of manganese (CCREM 1987). In 1988-89, mean concentrations of total manganese along the mainstem ranged from approximately 0.02 mg/L at the B.C.-Alberta border to 0.17 mg/L at Peace Point (Fig. 37). Mean total manganese concentrations in the tributaries

were higher than in the mainstem (Fig. 38). Dissolved manganese was generally less than the detection limit of 0.004 mg/L. For both historical and survey data, samples from mainstem sites and tributaries were, at times, non-compliant with the ASWQO of 0.05 mg/L and the CWQG for irrigation water of 0.2 mg/L total manganese. However, effluent loads of manganese were negligible (Table 9) and the high concentrations were likely a result of natural processes.

4.3.7.16 Mercury

In freshwater environments, mercury compounds are often sorbed to particulate matter and to sediments (CCREM 1987). The mercury content of sediments is highly variable; the lowest concentrations are associated with sand and the highest with organic sediments. In 1988-89, concentrations of total mercury in the Peace River mainstem and its tributaries were below the detection limit of 0.05 μg/L and all 1988-89 samples complied with the ASWQO and CWQG for freshwater aquatic life of 0.1 μg/L. However, non-compliance for mercury has been recorded previously in the Peace River at the B.C.-Alberta border (20 July 1987 - 0.3 μg/L) and at Dunvegan (3 of 22 samples - range 0.12 - 0.15 μg/L). These non-compliant values were within the range reported for other rivers in northern Alberta (Hamilton et al. 1985).

4.3.7.17 Molybdenum

The weathering of igneous and sedimentary rocks constitutes an important natural source of molybdenum to the aquatic environment (CCREM 1987). In 1988-89, total molybdenum concentrations were below the detection limit of 0.001 mg/L in most surface water samples; the maximum concentration measured was 0.095 mg/L in the mainstem and 0.081 mg/L in the Boyer River. Concentrations of dissolved molybdenum were generally below 0.001 mg/L. There are no ASWQO for molybdenum and the CWQG pertain to irrigation (0.05 mg/L), which is negligible in the Peace River Basin.

4.3.7.18 Nickel

Nickel enters the aquatic environment through weathering of rocks and as a result of human activities, primarily the burning of fossil fuels (CCREM 1987). In 1988-89, mean total nickel concentrations in the Peace River mainstem ranged from 0.007 mg/L near the B.C.-Alberta border to 0.023 mg/L near Peace Point (Fig. 39). Mean total nickel concentrations in most tributaries were slightly higher than in the mainstem (Fig. 40). On average, dissolved nickel comprised nearly half (48 %) of total nickel in Peace River surface waters (Appendix V). In 1988-89, samples from all sites on the mainstem and all tributaries, with the exception of one sample from the Boyer River, complied with the CWQG for freshwater aquatic life of 0.065 mg/L. All historical data, except for one sample from the mainstem at Ft. Vermilion (18 June 1972 - 0.87 mg/L extractable nickel), complied with the CWQG. There are no ASWQO for nickel.

4.3.7.19 Selenium

Selenium occurs naturally in trace amounts in water as a result of geochemical weathering and erosion of soils (CCREM 1987). In 1988-89, total selenium concentrations were low in the Peace River mainstem and its tributaries; the maximum concentrations were 0.0014 and 0.0031 mg/L, respectively. Dissolved selenium was generally below the detection limit of 0.0002 mg/L. In 1988-89, all sites on the mainstem complied with the ASWQO of 0.01 mg/L. On a few occasions, both historical and survey data from the mainstem and some tributaries were non-compliant with the CWQG for freshwater aquatic life of 0.001 mg/L.

4.3.7.20 Silver

Natural processes such as weathering release silver to the environment (CCREM 1987). However, with the exception of one sample

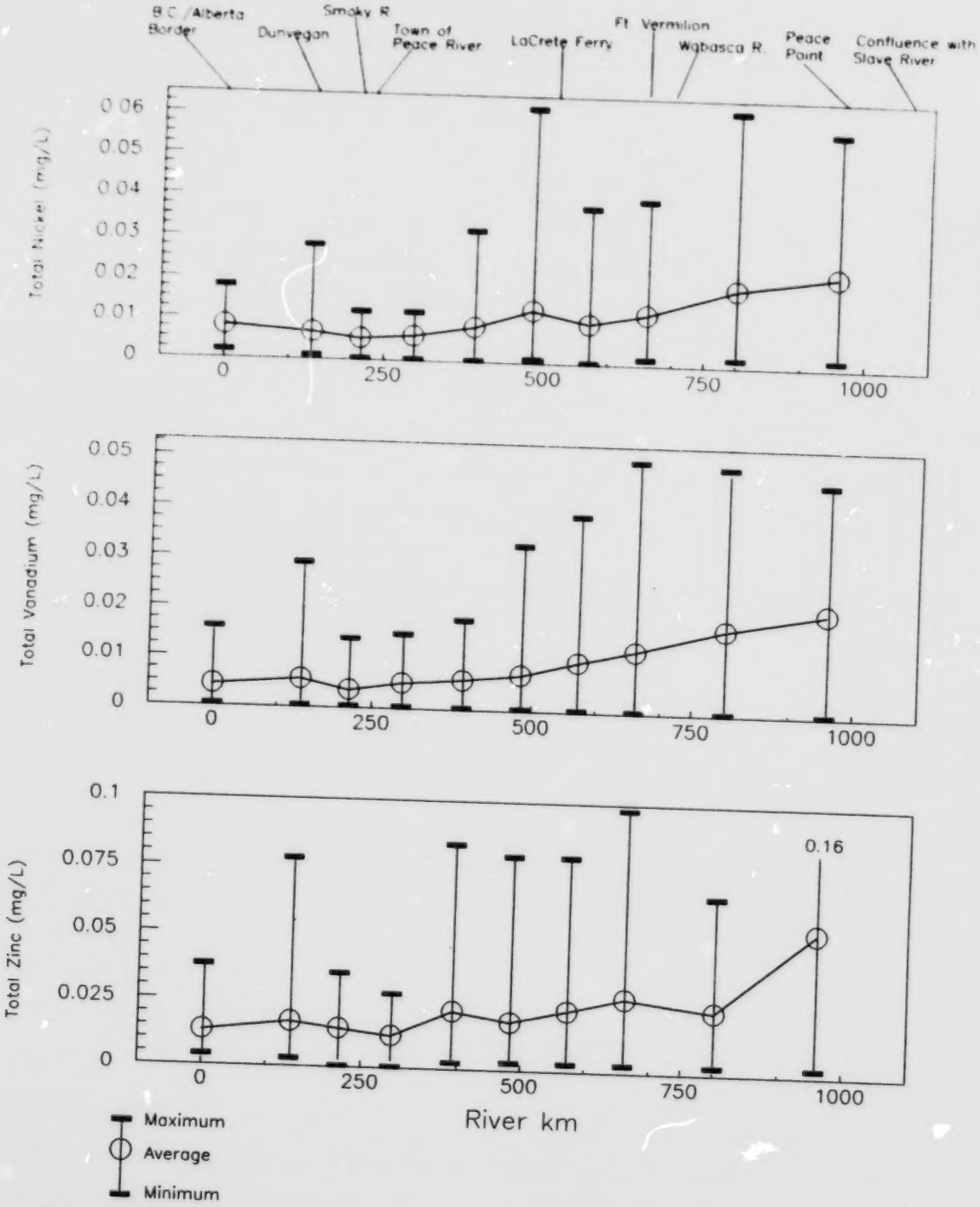


Fig. 39. Nickel, vanadium, and zinc concentrations in the Peace River, 1988–89.

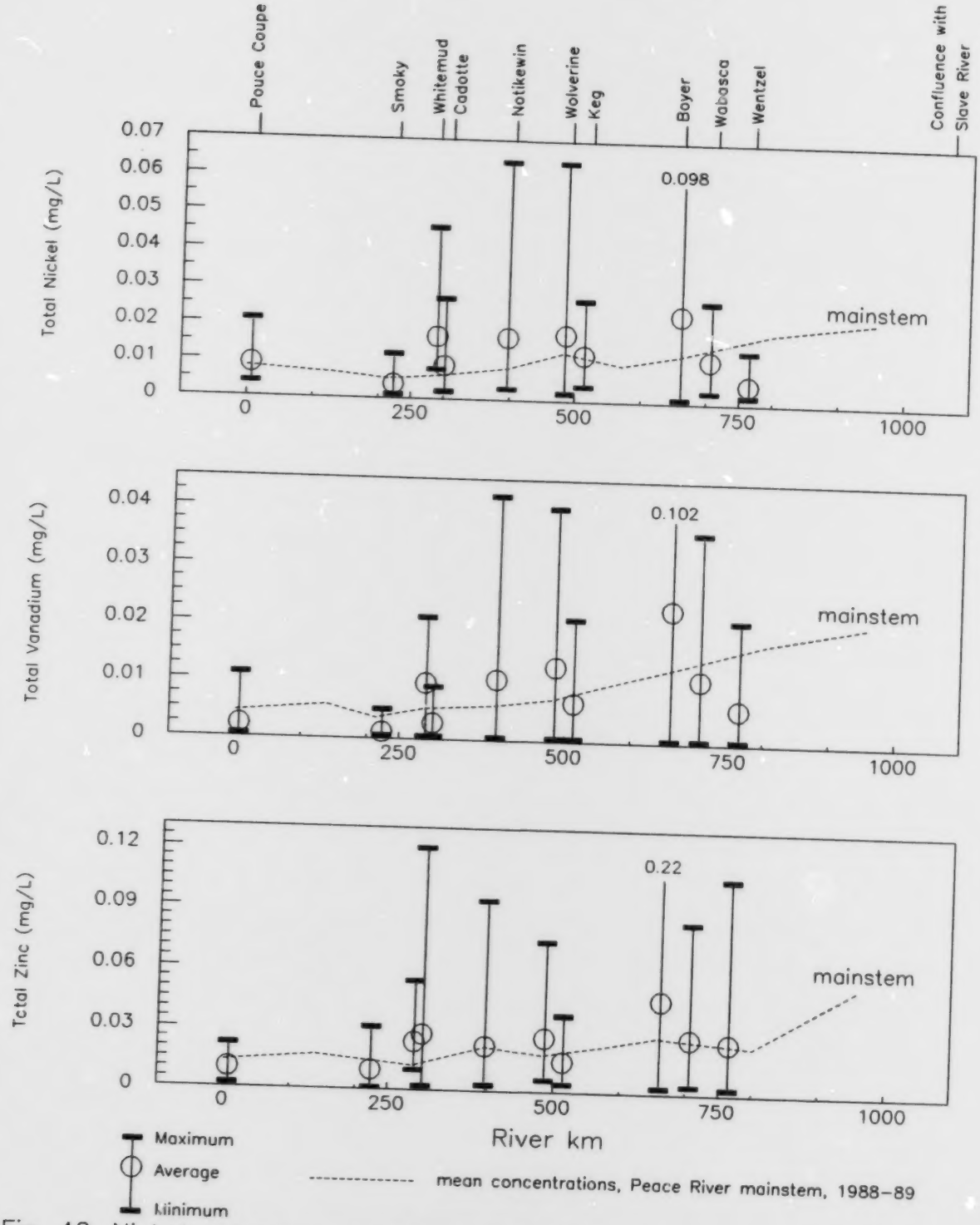


Fig. 40. Nickel, vanadium, and zinc concentrations in tributaries to the Peace River, 1988–89.

from the Keg River (0.002 mg/L), total silver concentrations in the Peace River mainstem and its tributaries were below the detection limit of 0.001 mg/L. All historical and survey data complied with the ASWQO of 0.05 mg/L silver. The CWQG for freshwater aquatic life (0.1 μg/L) could not be evaluated as it was below the analytical detection limit.

4.3.7.21 Strontium

Strontium is a radionuclide that occurs in aquatic environments as a result of natural weathering of rocks containing uranium, thorium, and their daughter products (CCREM 1987). Strontium was not measured in the synoptic surveys, but historic data are available. Concentrations of extractable strontium in the mainstem have ranged from 0.06 to 0.45 mg/L and in the tributaries from 0.05 to 1.5 mg/L. Both the CWQG for freshwater aquatic life and the ASWQO for strontium pertain to radioactivity of ^{90}Sr (10 Bq/L); these data are not available for the Peace River system.

4.3.7.22 Thallium

Thallium is present in trace amounts in surface waters as a result of weathering of potassium minerals, such as feldspars and mica (CCREM 1987). Thallium was not measured in the synoptic surveys, but historical data from some tributaries are available. In all cases, concentrations of extractable thallium were below the detection limit of 0.1 or 0.2 mg/L. There are no ASWQO or CWQG for thallium.

4.3.7.23 Uranium

Uranium is a radionuclide that occurs in aquatic environments as a result of natural weathering of rocks, especially acidic igneous rocks, and from atmospheric deposition from the combustion of fossil fuels (CCREM 1987). Uranium was not measured in the synoptic surveys, and few historical data are available for the Peace River system.

Concentrations of dissolved uranium in the mainstem ranged from 0.0008 to 0.0014 mg/L and in the tributaries from 0.0005 to 0.0015 mg/L. These concentrations are within the range reported for other surface waters in western Canada (CCREM 1987). There are no ASWQO for uranium and the most stringent CWQG pertains to the use of water for irrigation (0.01 mg/L). All historical data were below that value.

4.3.7.24 Vanadium

Vanadium is released to the aquatic environment primarily by surface erosion (CCREM 1987). In 1988-89, mean total vanadium concentrations in the mainstem were low at the B.C.-Alberta border (0.004 mg/L) and increased to 0.021 mg/L near Peace Point (Fig. 39); mean concentrations in the tributaries were of similar magnitude to the mainstem (Fig. 40). Dissolved vanadium concentrations were generally below the detection limit of 0.001 mg/L. There are no ASWQO for vanadium and the CWQG is for irrigation water (0.1 mg/L). All historical and survey data were well below that value.

4.3.7.25 Zinc

Zinc enters the aquatic environment primarily as a result of geochemical weathering and anthropogenic emissions. Similar to the pattern observed for other metals in 1988-89, mean concentrations of total zinc increased gradually along the mainstem from 0.01 mg/L at the B.C.-Alberta border to 0.025 mg/L along most of the lower reach of the river (Fig. 39). The apparent increase at Peace Point was due to one high value (21 June 1988; Appendix V). Mean concentrations in the tributaries were similar to the mainstem (Fig. 40). Nearly half of the zinc was in the dissolved fraction. For both historical and survey data, samples from the mainstem and tributaries were, at times, non-compliant with the ASWQO of 0.05 mg/L and the CWQG for freshwater

aquatic life of 0.03 mg/L zinc. Dissolved zinc occasionally exceeded 0.03 mg/L, although concentrations were always less than 0.05 mg/L (Appendix V). The relatively high concentrations of zinc was probably a result of weathering of Cretaceous shales (Reeder et al. 1972), rather than loading from effluents (Table 9).

4.3.8 Cyanide

Cyanides are a diverse group of organic and inorganic compounds characterized by the presence of a -C≡N group. They are generally found in low concentrations in surface waters as a result of natural decomposition of plants that synthesize cyanoglycosides and from microorganisms that produce free cyanide during metabolic processes (CCREM 1987). In 1988-89, cyanide concentrations along most of the Peace River and in most tributaries were below the detection limit of 0.001 mg/L. Maximum concentrations of 0.004 and 0.002 mg/L were recorded in the mainstem and tributaries, respectively (Appendix V). All historical and survey samples from surface waters in the Peace River system were well below the CWQG for freshwater aquatic life and the ASWQO of 0.005 and 0.01 mg/L, respectively.

4.3.9 Nutrients

4.3.9.1 Nitrogen

Nitrogen can limit the growth of aquatic algae and macrophytes. In aquatic systems, nitrogen occurs in various inorganic forms (e.g., dissolved molecular nitrogen, nitrite, nitrate, ammonium, ammonia) and organic compounds (e.g., amino acids, amines, proteins). The different forms of nitrogen are linked together in the aquatic nitrogen cycle through the processes of ammonification, nitrification, and denitrification. Nitrite (NO_2^-) is an intermediate, partly oxidized ion, which is usually scarce in natural surface waters because it is

rapidly oxidized to the more stable and abundant nitrate ion (NO_3^-). Nitrate is assimilated into nitrogen compounds by autotrophic organisms. During laboratory analysis, nitrate is reduced to nitrite; thus its concentrations are reported as (NO_2^-+NO_3^-)-N.

Free ammonia (NH_3) exists in equilibrium with its ion, ammonium (NH_4^+), the latter dominating in most natural freshwaters. The analytical method detects both NH_3 and NH_4^+ and reports a total, which is usually referred to as ammonia nitrogen (NH_3-N). Ammonia is generated by heterotrophic bacteria as a primary nitrogenous end product of decomposition of nitrogenous organic compounds and is readily assimilated by macrophytes (Wetzel 1983). In aquatic systems, free ammonia is toxic, but it is generally scarce. The partitioning between NH_3 and NH_4^+ depends on pH and water temperature. The proportion of NH_3 increases with temperature, and NH_4^+ is predominant below a pH of 9 (Stumm and Morgan 1981). In the Peace River system, pH was generally below 8; thus NH_4^+ ammonium was the dominant form of reduced nitrogen.

A number of different nitrogen fractions have been analyzed from the samples collected in the Peace River at Dunvegan. Dissolved nitrogen (DN) includes NH_3-N plus (NO_2^-+NO_3^-)-N. Total nitrogen (TN) is total Kjeldahl nitrogen (organic nitrogen plus NH_3-N) plus (NO_2^-+NO_3^-)-N, and particulate nitrogen (PN) is TN minus DN. At Dunvegan, all nitrogen fractions increased significantly with discharge (Table 6). Concentrations of DN followed a seasonal pattern of peaks in April and May and lows in August to October (Fig. 41). Peak concentrations of PN and TN occurred from April to June and the lows from January to February. This pattern is similar to that for concentrations of suspended solids (Fig. 15). In contrast, concentrations of (NO_2^-+NO_3^-)-N were highest in winter and spring and lowest in summer and early fall (Fig. 41). This seasonal pattern for (NO_2^-+NO_3^-)-N has been observed in other rivers in Alberta (Hamilton et al. 1985; EQMB unpublished data) and may be a result of nitrate assimilation during the summer by

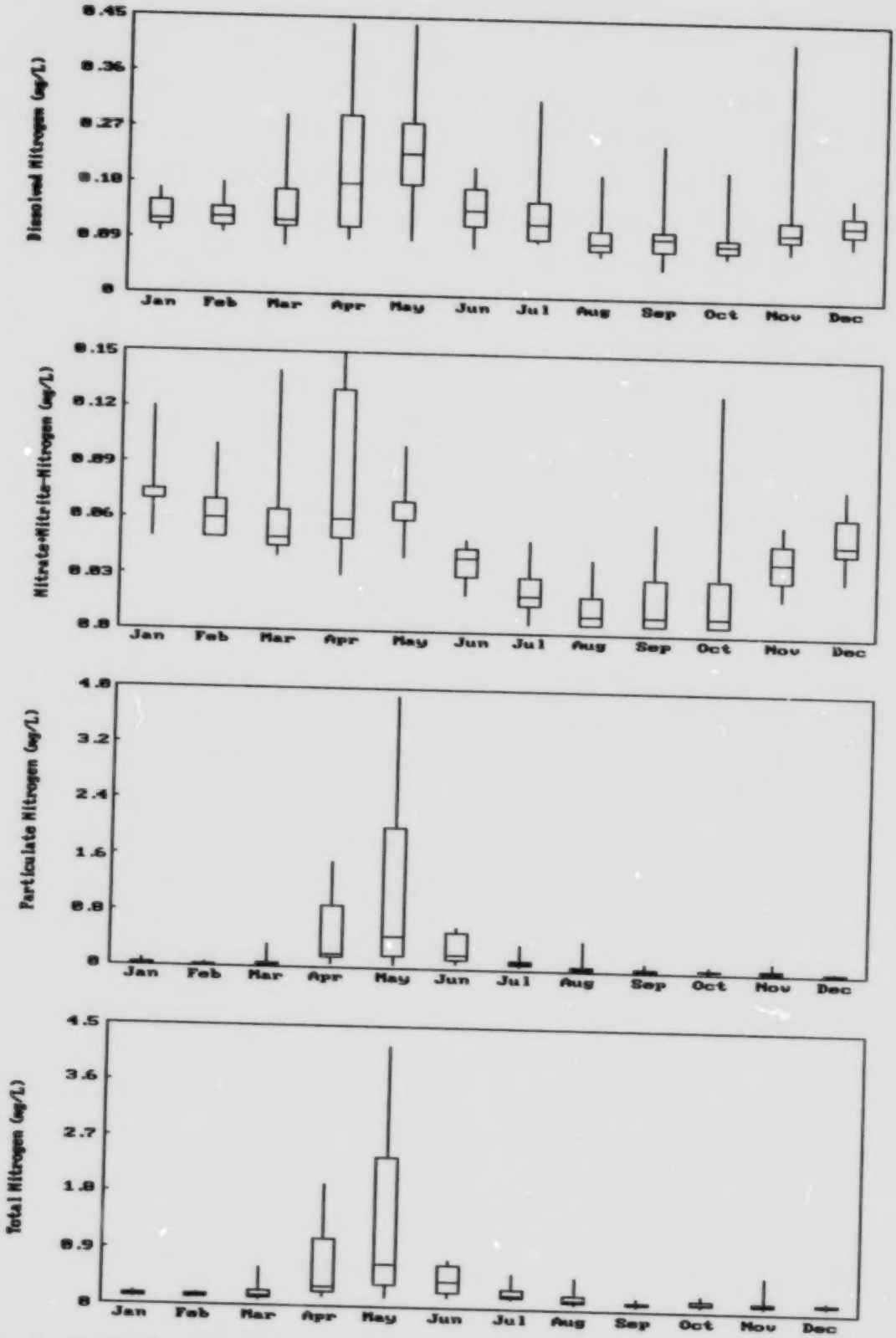


Fig. 41. Seasonal patterns for nitrogen in the Peace River at Dunvegan. Flow-adjusted concentrations (not shown) follow the same patterns as for actual concentrations.

bacteria and algae and nitrification during the winter.

For DN and TN, both actual and flow-adjusted concentrations decreased significantly from 1978 to 1988 in the Peace River mainstem (Fig. 42). The decreases were slight - 0.003 and 0.005 mg/L/yr for DN and TN, respectively. For two other nitrogen fractions, $(NO_2^- + NO_3^-)$-N and PN, there were significant decreases in the flow-adjusted, but not the actual concentrations (Table 8). This difference may be a result of the decreased variance in the flow-adjusted data (i.e., variance due to discharge was reduced), thus, the trend would be more easily detected with those data. Possible reasons for the decreases in nitrogen concentrations are: (1) lower concentrations in the Williston Reservoir as a result of reservoir aging, and/or (2) a decrease in the nitrogen load to the river from sewage effluents and diffuse sources such as surface runoff of agricultural fertilizers.

In 1988-89, mean concentrations of total nitrogen (TN) along the Peace River increased from approximately 0.3 mg/L near the B.C.-Alberta border to 0.9 mg/L near Peace Point (Fig. 43). Mean concentrations of TN in the tributaries were higher than in the mainstem (Fig. 44). Even so, loading from the tributaries that were sampled could not account for the longitudinal increase along the mainstem (Table 9). Rather, the increase in TN concentrations was due to increased concentrations of suspended solids in the lower reaches of the river. Concentrations of total nitrogen and suspended solids were highly correlated (1988-89 mainstem data: $\underline{r} = 0.74$; df = 68; $\underline{P} < 0.001$).

In both the mainstem and tributaries, total nitrogen was largely organic - TKN minus ammonia averaged 87 % of TN. In winter, the inorganic fraction was predominantly $(NO_2^- + NO_3^-)$-N and in summer predominantly NH_3-N. Similar to TN, NH_3-N concentrations were highest in the lower reaches of the river, although there was an initial decline in concentrations from the B.C.-Alberta border to the confluence with the Smoky River (Fig. 43). Average concentrations were considerably

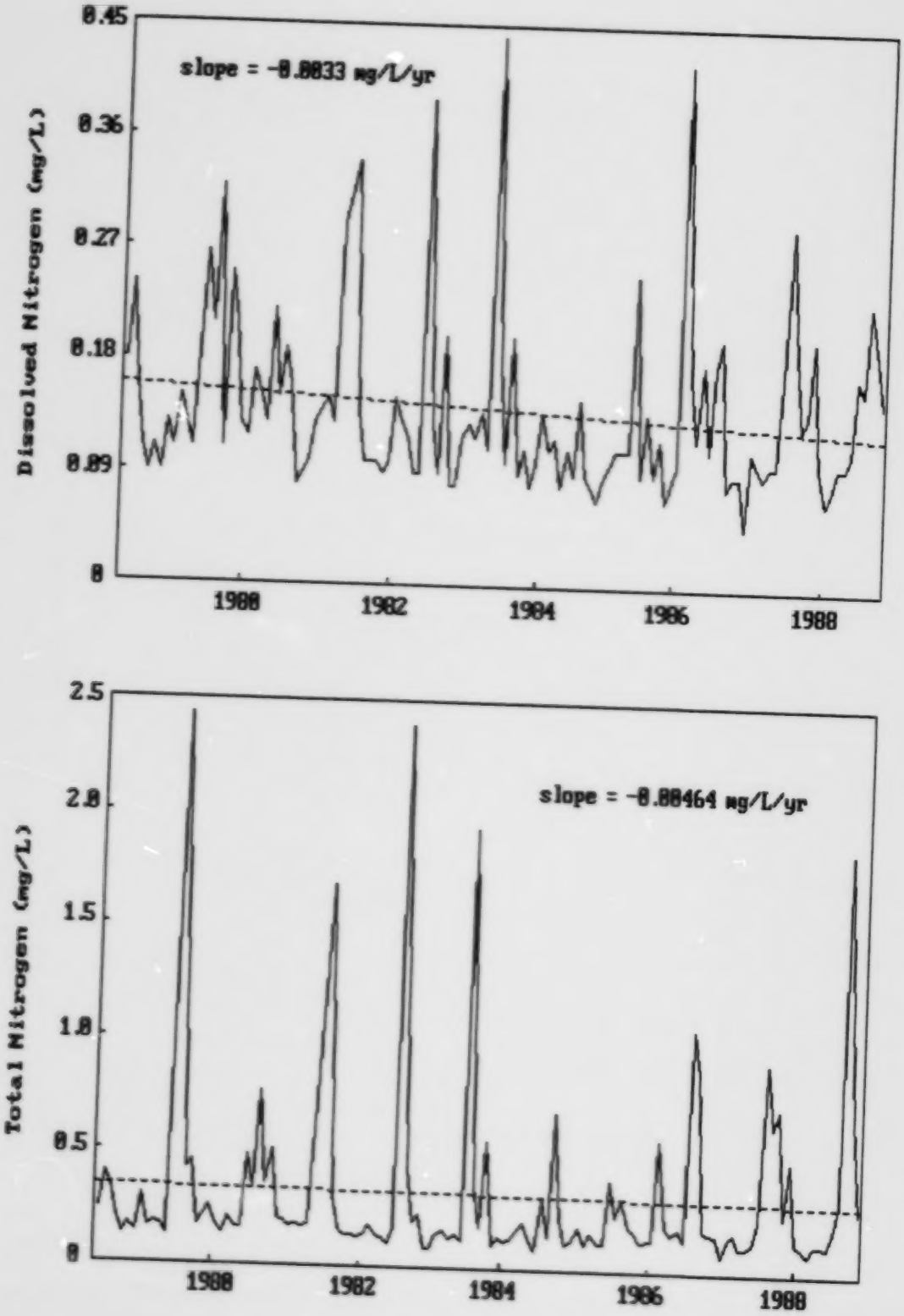


Fig. 42. Long-term trends for nitrogen in the Peace River at Dunvegan.

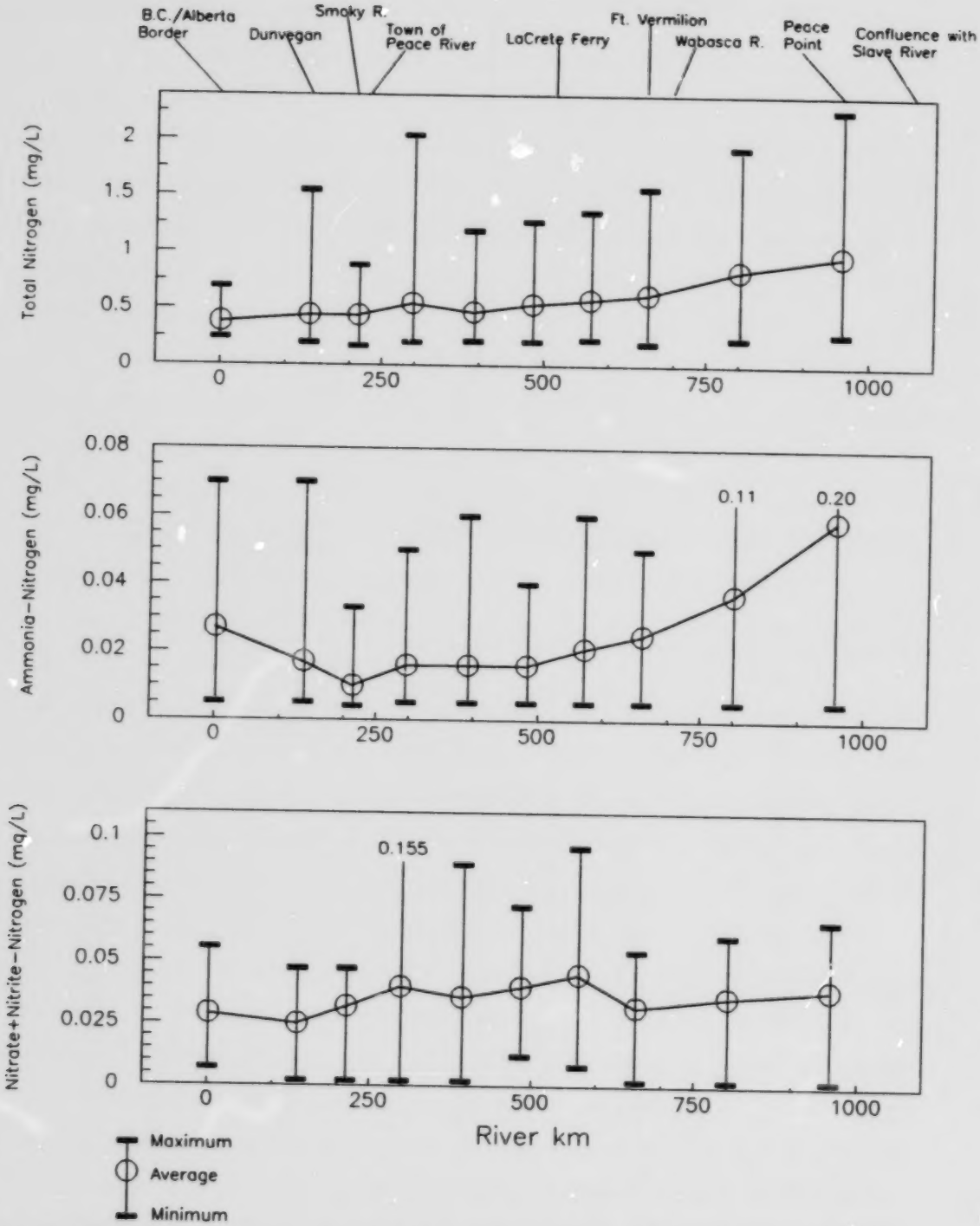


Fig. 43. Total nitrogen, ammonia, and nitrate+nitrite concentrations in the Peace River, 1988–89.

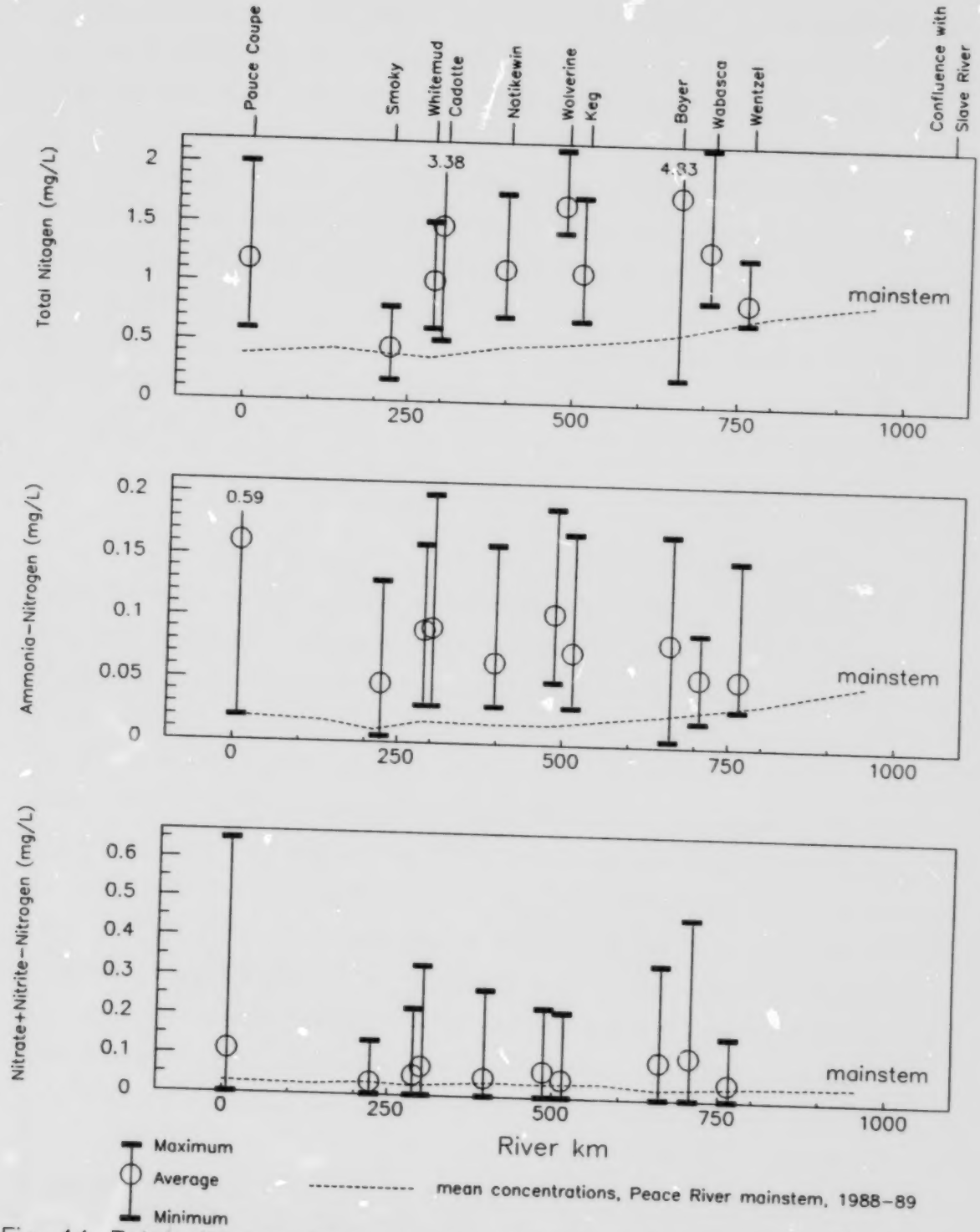


Fig. 44. Total nitrogen, ammonium, and nitrate+nitrite concentrations in tributaries to the Peace River, 1988-89.

higher in the tributaries than in the mainstem (Fig. 44). In contrast to TN and NH_3-N, average concentrations of $(NO_2^- + NO_3^-)$-N were relatively constant along the mainstem (Fig. 43) and mean concentrations in the tributaries were similar to, or only slightly higher than, the mainstem (Fig. 44).

Both historical and survey data indicate that TN values from the mainstem and most tributaries were often non-compliant with the ASWQO of 1.0 mg/L TN. There is no CWQG for TN. For NH_3-N, the CWQG for freshwater aquatic life ranges from 0.93 to 1.53 mg/L for the pH and water temperatures observed in the Peace River system. All data from the mainstem and tributaries complied with that guideline. There are no ASWQO for nitrogen fractions.

4.3.9.2 Phosphorus

Phosphorus is the nutrient that limits productivity in most freshwater ecosystems. Elevated concentrations of phosphorus often result in increased biomass of algae, aquatic macrophytes, and associated biota. Phosphorus occurs in inorganic and organic compounds and in dissolved and particulate forms.

Total phosphorus (TP) concentrations in the Peace River at Dunvegan increased significantly with discharge (Table 6). Both actual and flow-adjusted concentrations of TP were highest in late spring and summer and lowest in fall and winter (Fig. 45). There were no significant changes in phosphorus concentrations from 1978 to 1987 (Table 8). On average, 80 % of phosphorus in the Peace River at Dunvegan was particulate, and concentrations of TP were highly correlated to suspended solids ($\underline{r} = 0.88$; df = 124; $\underline{P} < 0.001$). Thus, the seasonal pattern for TP concentrations followed the seasonal pattern for suspended solids concentrations (Fig. 15).

In 1988-89, mean concentrations of TP increased along the Peace River from 0.07 mg/L at the B.C.-Alberta border to 0.37 mg/L at Peace

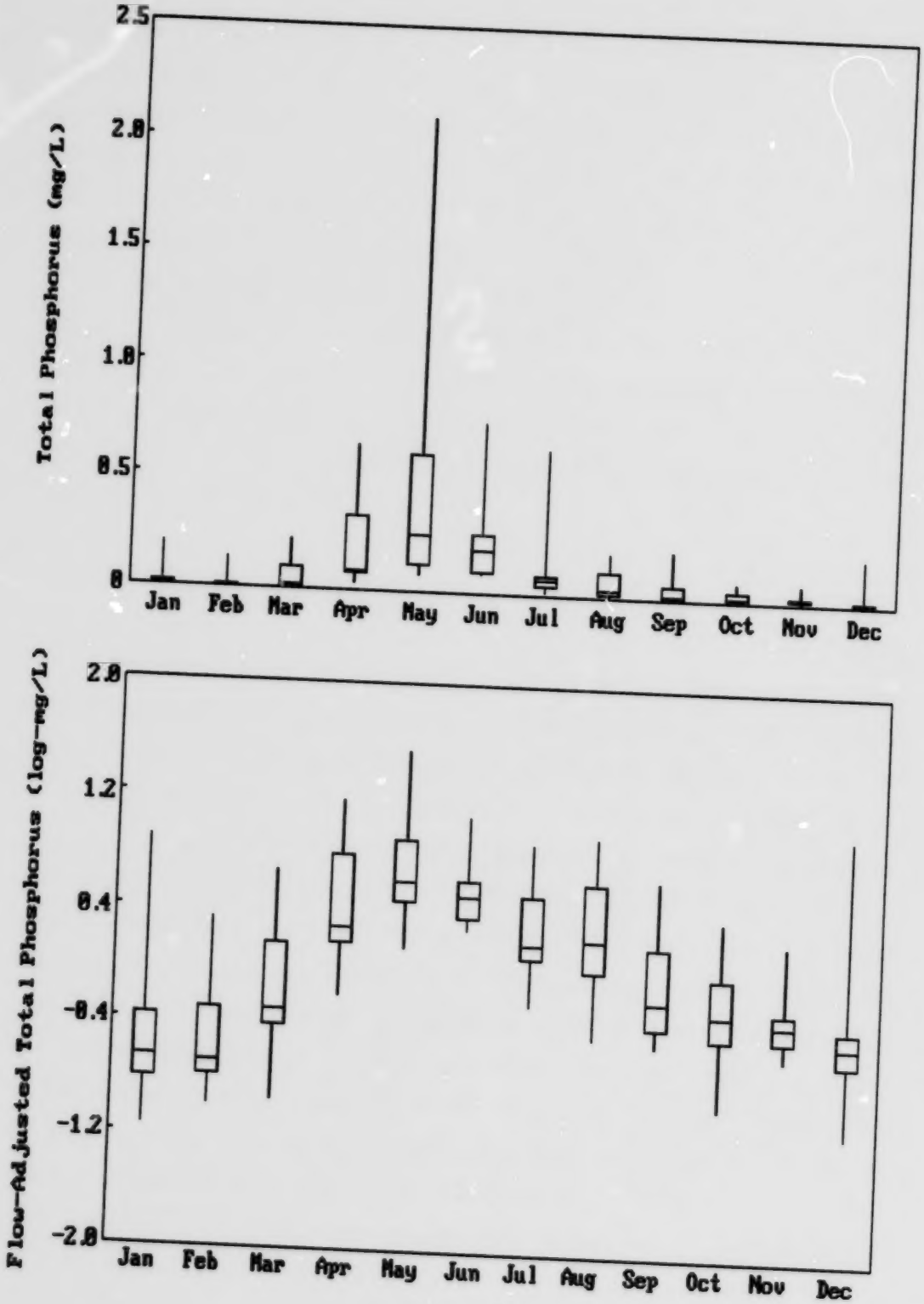


Fig. 45. Seasonal trends in total phosphorus in the Peace River at Dunvegan.

Point (Fig. 46), largely due to the increase in suspended solids concentrations. Mean concentrations of TP in the tributaries were quite variable, although generally higher than in the mainstem (Fig. 47). Similar to long-term data from Dunvegan, particulate phosphorus accounted for 75 % of TP during the 1988-89 surveys. Mean TDP concentrations along the mainstem followed a similar longitudinal pattern to that observed for TP (Fig. 46). Mean concentrations of TDP in the tributaries were always higher than in the mainstem (Fig. 47).

For both historical and survey data, most samples from the mainstem and tributaries were non-compliant with the ASWQO of 0.05 mg/L total phosphorus as a result of naturally high suspended solids concentrations. There are no CWQG for phosphorus.

4.3.9.3 Silica

Silica refers to the oxides of silicon in water, which are primarily SiO_2 and H_4SiO_4 (CCREM 1987). Silica is present in most surface waters and originates primarily from weathering of aluminosilicate minerals. Adsorption is the only significant mechanism of inorganic removal of natural silica from water (Wetzel 1983). Silica is an essential nutrient for diatom algae; thus, high anthropogenic loads may contribute to increased diatom production in rivers.

Similar to the Athabasca River and many other rivers (Noton and Shaw 1989), silica concentrations in the Peace River at Dunvegan were not correlated to discharge (Table 6). There were, however, significant differences between month: concentrations were highest in winter and spring and lowest in summer (Fig. 48). The low summer concentrations may have been a result of silica uptake by diatoms. Silica concentrations in the Peace River have decreased slightly (0.04 mg/L/yr) from 1978 to 1988 (Fig. 48), perhaps as a result of changes in Williston Reservoir and/or changes in the diatom community in the river.

In 1988-89, there was little variability in mean silica

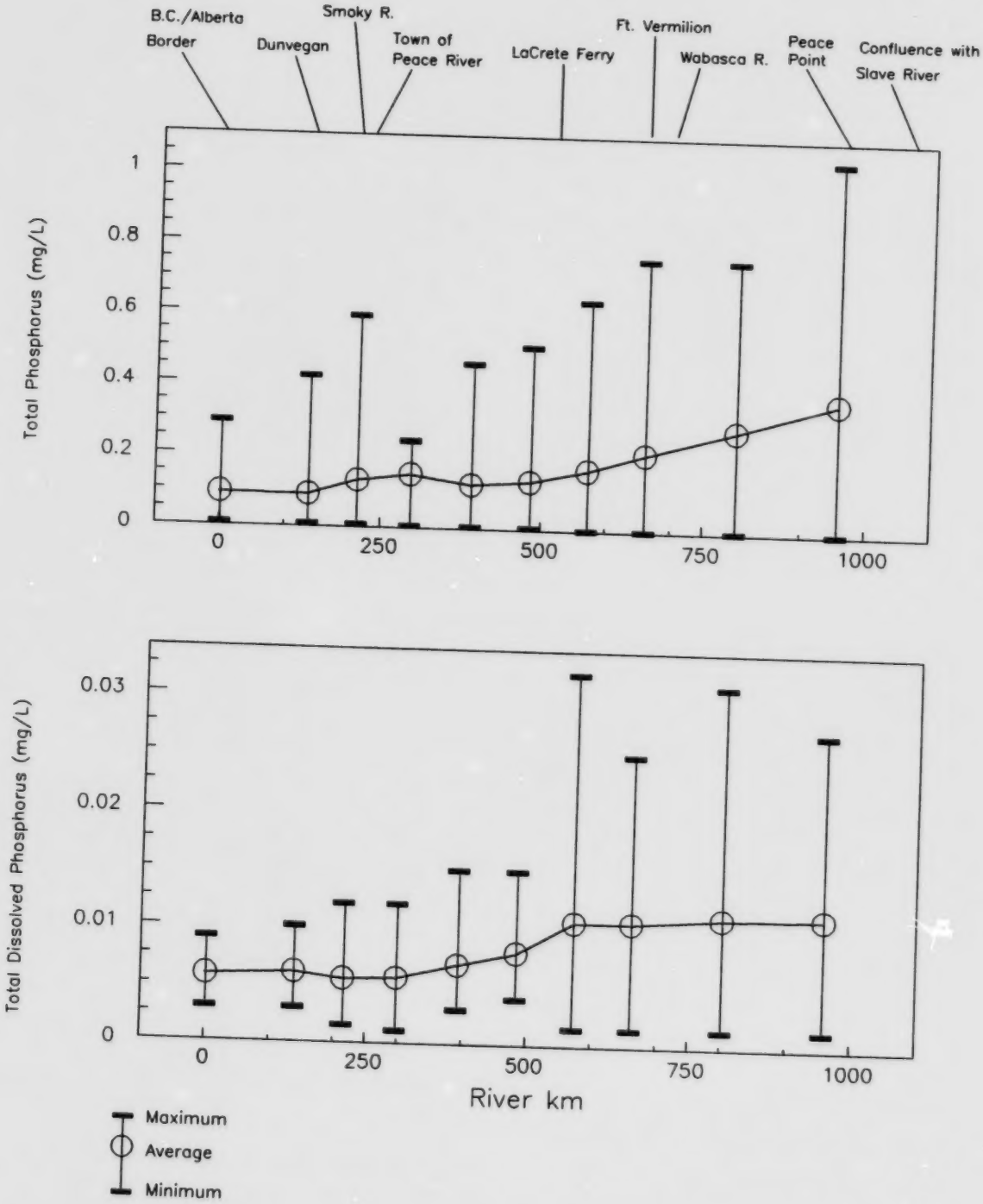


Fig. 46. Total and total dissolved phosphorus concentrations in the Peace River, 1988–89.

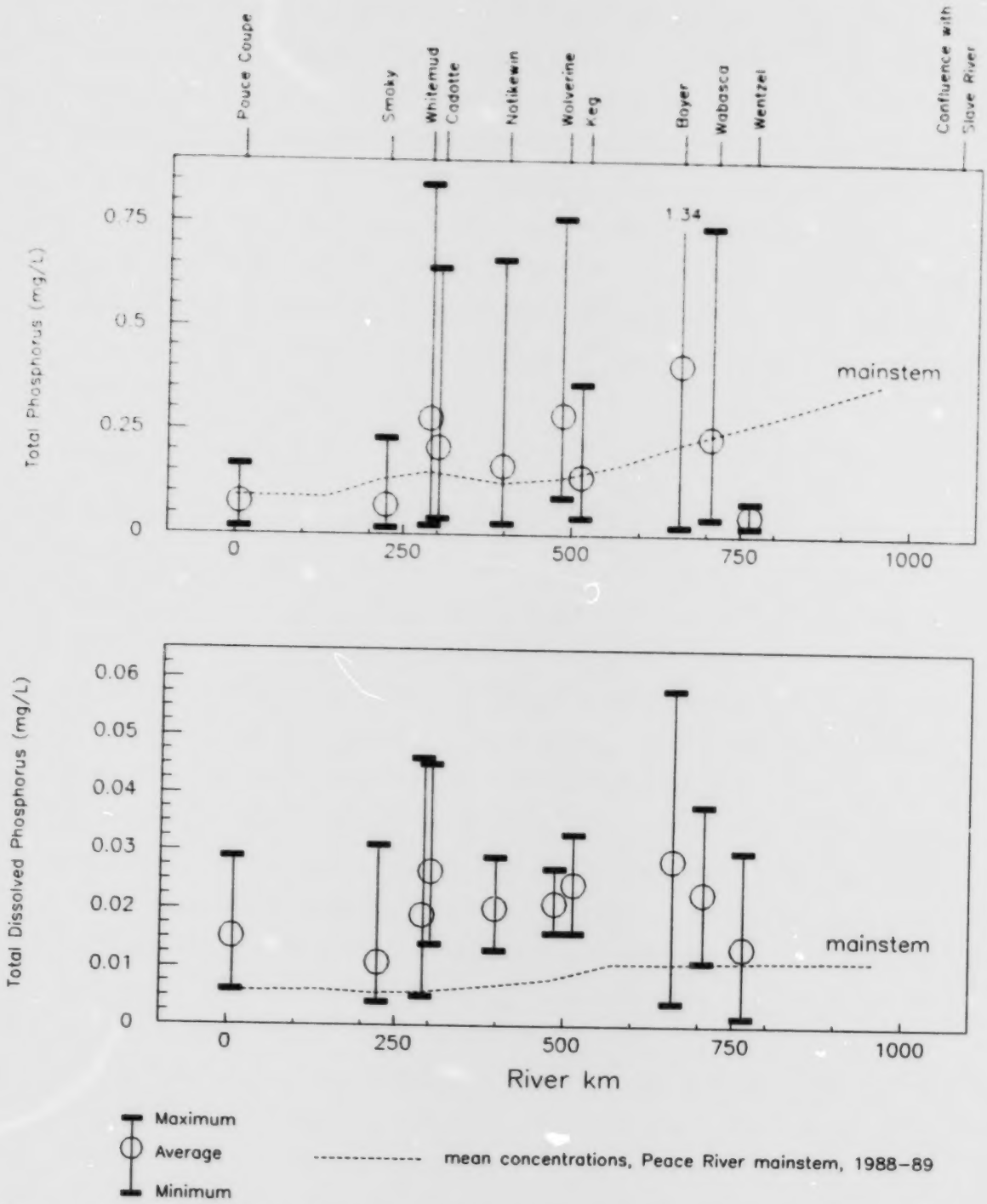


Fig. 47. Total and total dissolved phosphorus concentrations in tributaries to the Peace River, 1988–89.

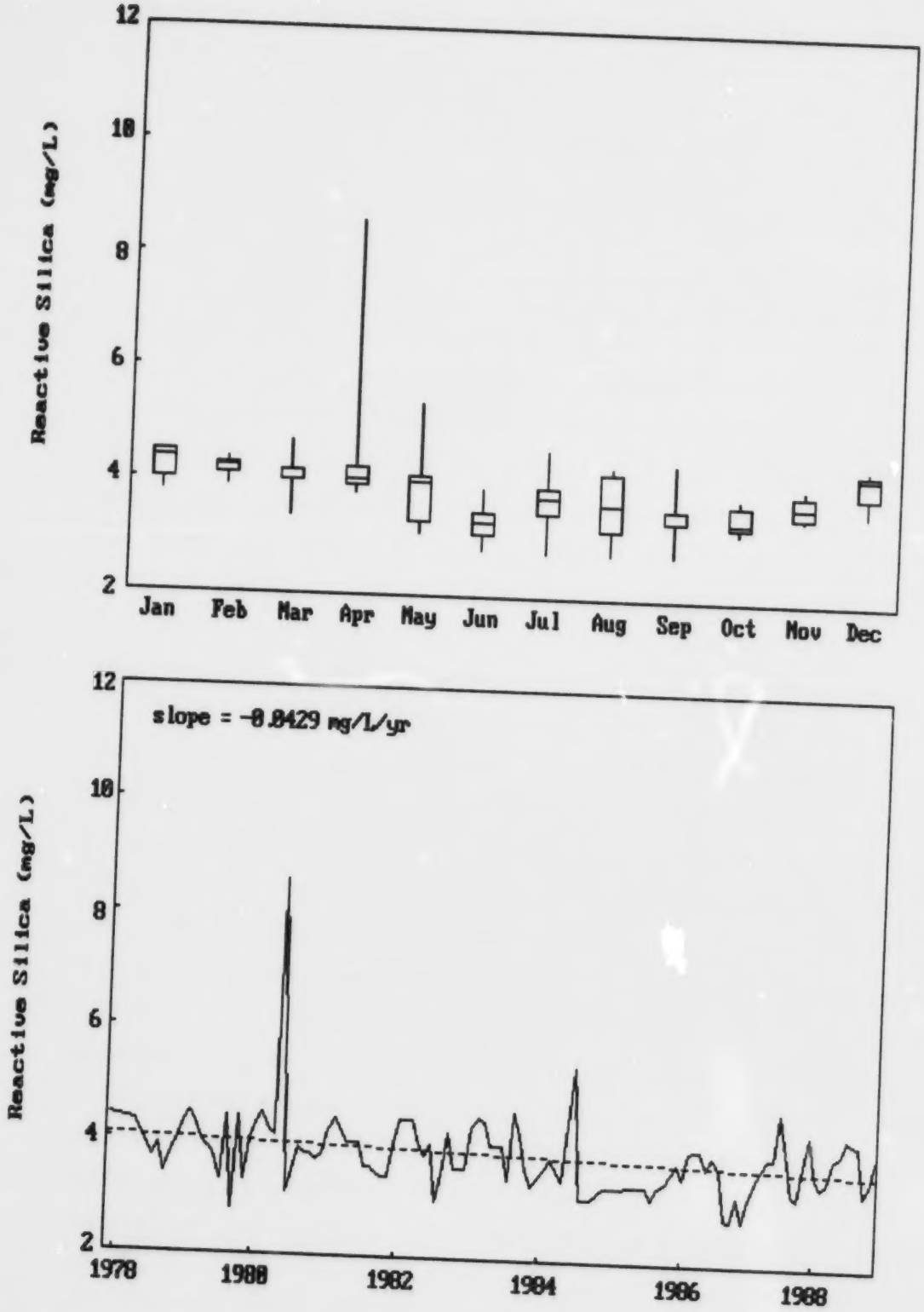


Fig. 48. Seasonal and long-term trends in silica in the Peace River at Dunvegan.

concentrations along the mainstem, which ranged from 4.1 to 4.6 mg/L (Fig. 49). Mean concentrations in the tributaries ranged from 3.7 to 6.8 mg/L and tended to be slightly higher than in the mainstem (Fig. 49). There are no ASWQO or CWQG for silica.

4.4 ORGANIC CONSTITUENTS

4.4.1 Organic Carbon

Carbon is the most abundant element found in all organisms. In aquatic environments, organic carbon is produced *in situ* by plant photosynthesis and bacterial fixation. Leaching of humic substances and degradation of plant and animal materials are also natural sources of organic carbon to surface waters. In addition, runoff from agricultural land and discharge of municipal and industrial wastewaters, especially from pulp mills, contributes organic carbon to surface waters.

In the Peace River at Dunvegan, particulate organic carbon (POC) concentrations increased significantly with flow while dissolved organic carbon (DOC) concentrations were independent of flow (Table 6). Concentrations of both DOC (actual) and POC (actual and flow-adjusted) followed a seasonal pattern of high concentrations in late spring and summer and low concentrations in late fall and winter (Fig. 50), as was observed for suspended solids (Fig. 15). On average, the dissolved fraction comprised 63 % of total organic carbon at Dunvegan. There were no long-term changes in concentrations of either DOC or POC at Dunvegan (Table 8).

In 1988-89, concentrations of DOC in the mainstem and tributaries averaged 94 and 97 %, respectively, of total organic carbon (TOC). Thus, the observed longitudinal trend for DOC of a relatively constant concentration of 5 mg/L from the B.C.-Alberta border to Ft. Vermilion and an increase to 8 mg/L in the lower reach of the river, was similar to the observed trend for TOC (Fig. 51). Concentrations of organic

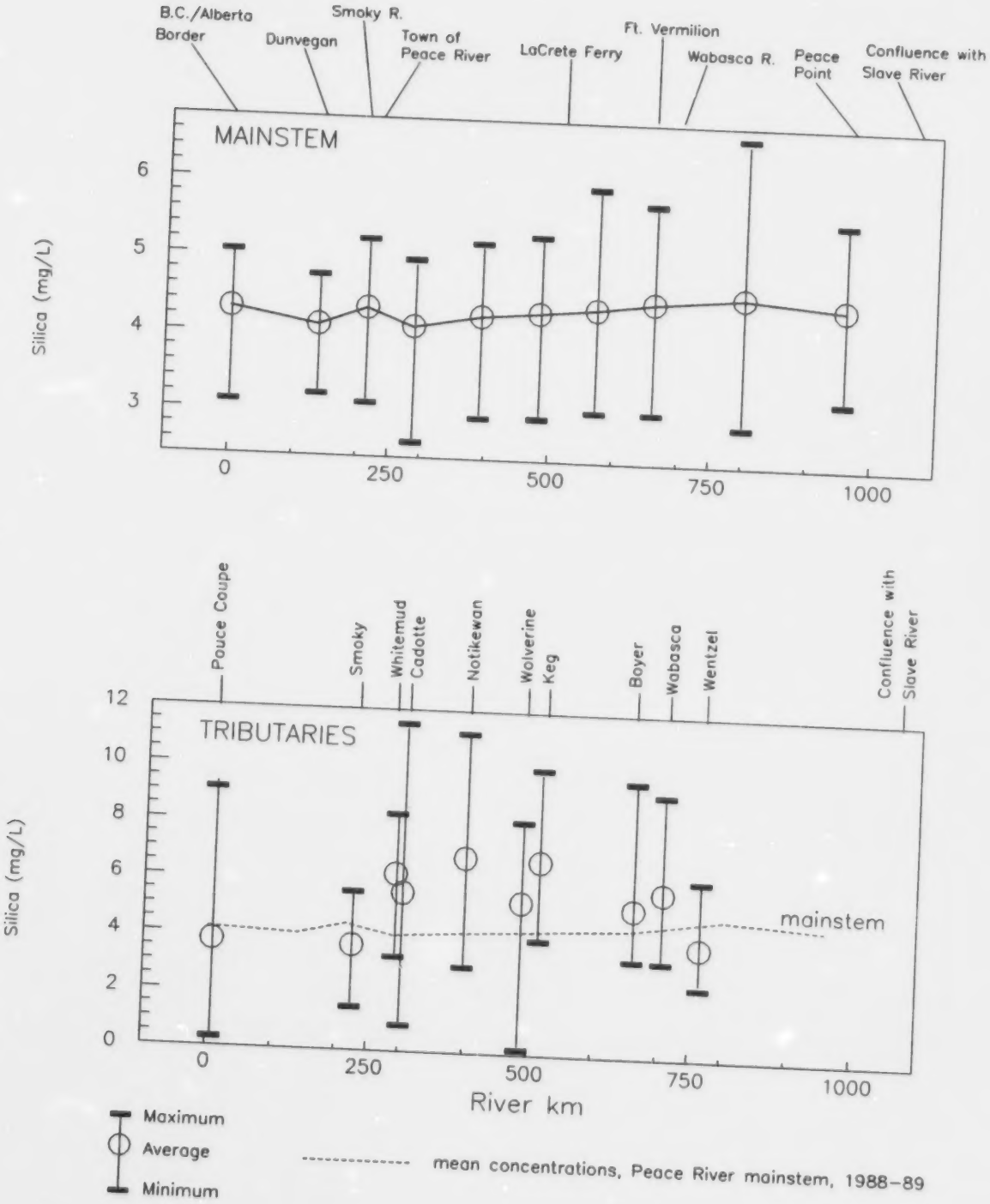


Fig. 49. Silica concentrations in the Peace River system, 1988–89.

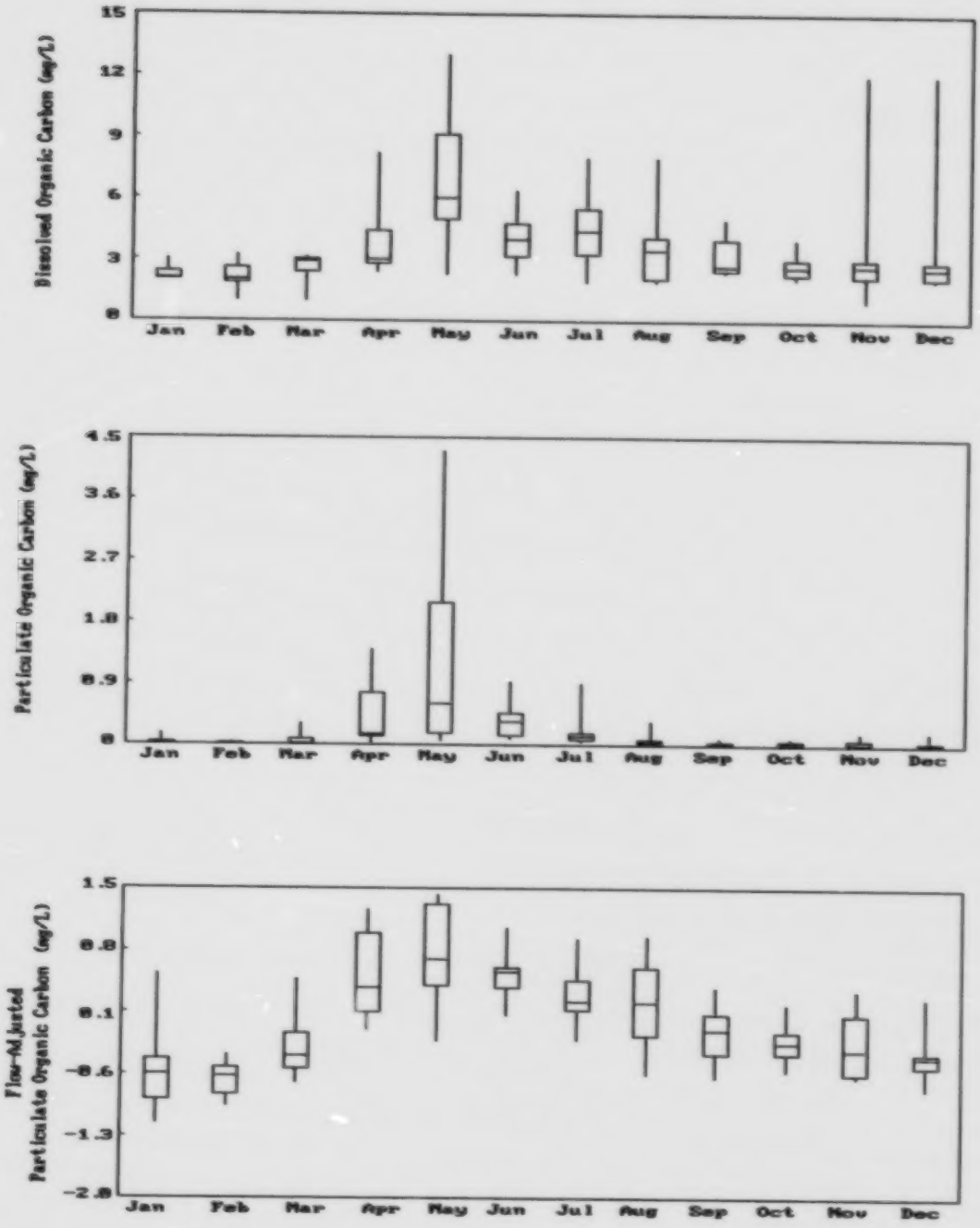


Fig. 50. Seasonal trends in organic carbon in the Peace River at Dunvegan.

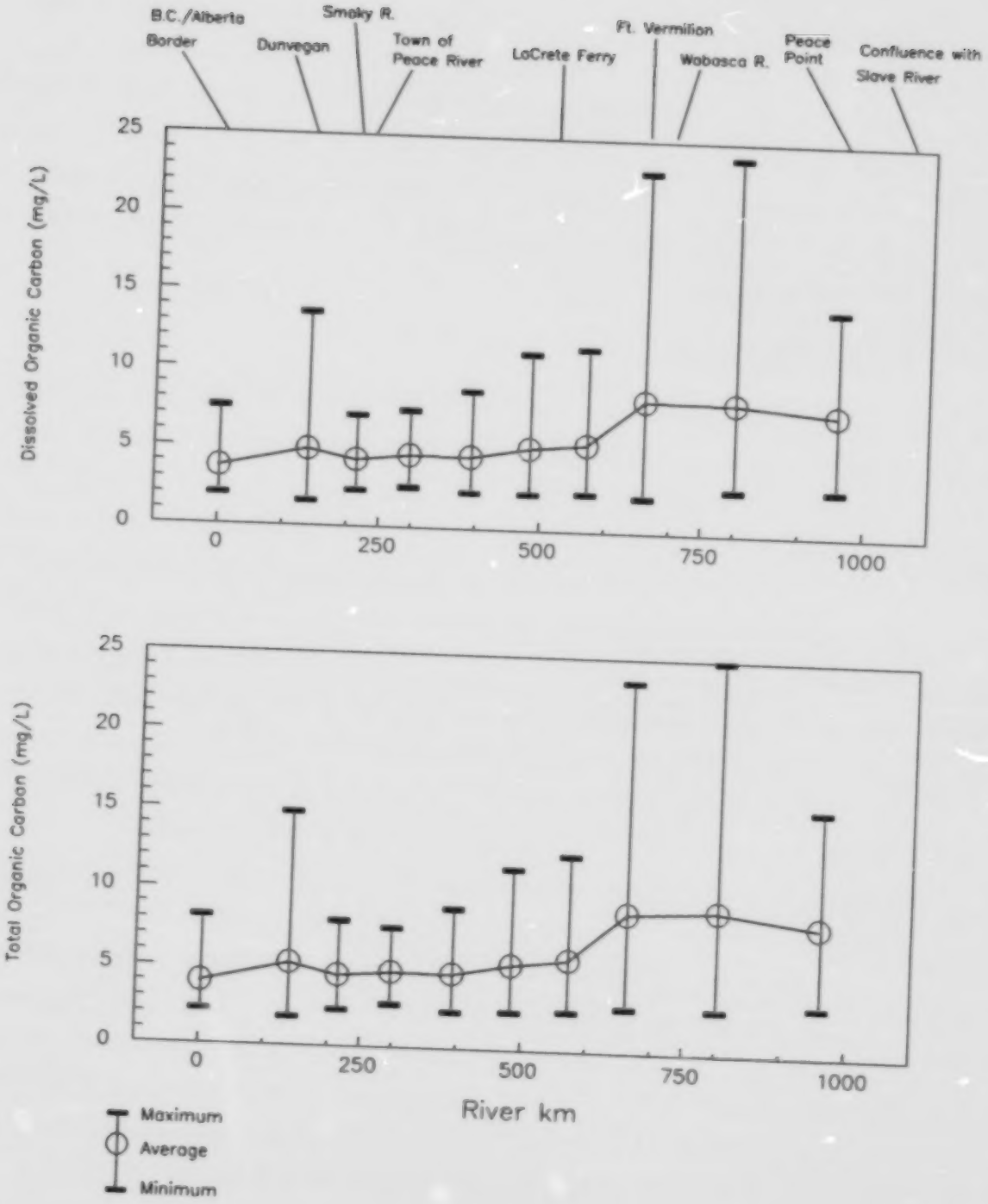


Fig. 51. Organic carbon concentrations in the Peace River, 1988–89.

carbon in all tributaries except the Smoky River were 4- to 5-fold higher than the mainstem (Fig. 52) and contributed to the observed increase of organic carbon in the lower reaches of the Peace River (Table 9). Organic carbon concentrations in the Smoky River were more similar to the Peace River, likely because of the similar Cordilleran origin of these rivers. In contrast, many of the other tributaries originate in areas with extensive peatland development, which would contribute to their high organic contents. There are no ASWQO or CWQG for organic carbon.

4.4.2 Oil and Grease

Oil and grease are not specific substances but may include thousands of organic chemicals with different physical, chemical, and toxicological properties (CCREM 1987). They are defined by their method of analysis, which in the case of the 1988-89 synoptic surveys was trichlorotrifluoroethane extraction and infrared spectrophotometry. In addition to oil and grease, other organic substances such as sulphur compounds, certain organic dyes, chlorophyll, and natural fats and oils may be measured in the test (Clesceri et al. 1989). Furthermore, short-chain hydrocarbons, single aromatics, petroleum distillates, and heavier residuals of petroleum may not be extracted with the solvent. Oil and grease is, thus, fairly non-specific with regard to natural surface waters, but it can be used to characterize effluents and petroleum spills.

There are no historical oil and grease data for the Peace River system. The 1988-89 synoptic survey data revealed no consistent seasonal patterns in concentrations of oil and grease. In the Peace River, mean oil and grease concentrations followed no distinct pattern from the B.C.-Alberta border to Peace Point, ranging from approximately 0.3 to 0.7 mg/L (Fig. 53). High concentrations were recorded at the B.C.-Alberta border, probably as a result of natural processes since the oil

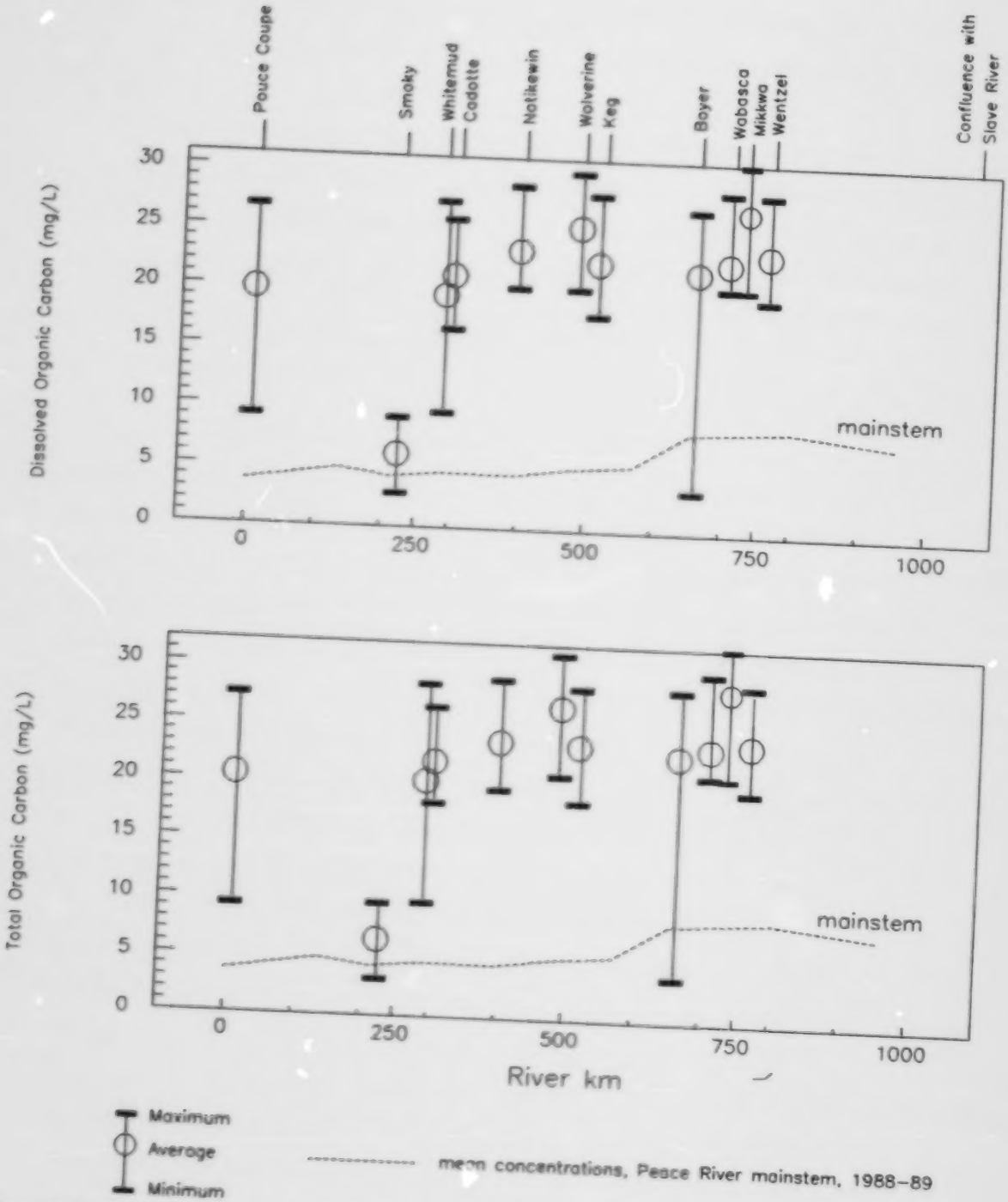


Fig. 52. Organic carbon concentrations in tributaries to the Peace River, 1988–89.

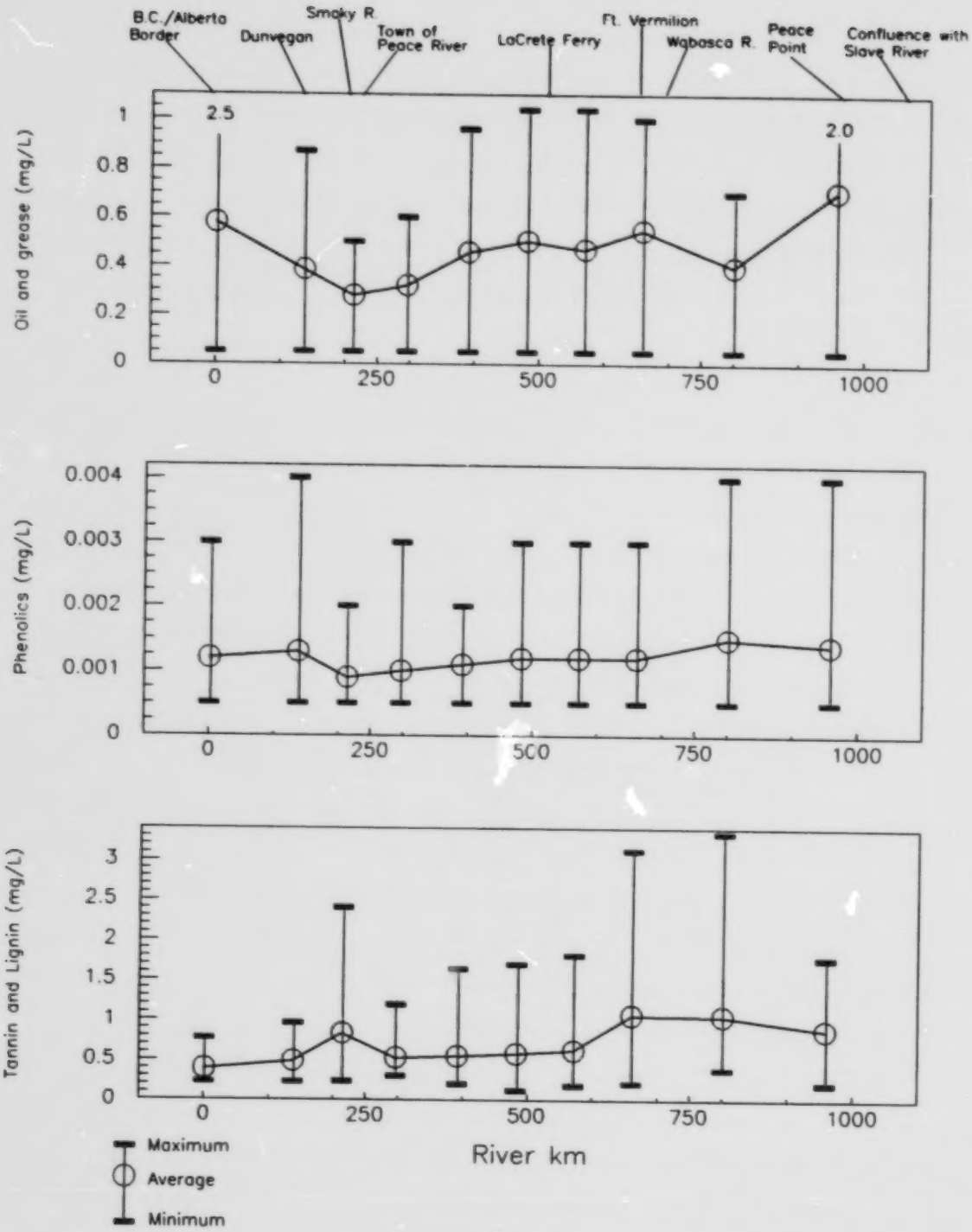


Fig. 53. Oil and grease, phenolics, and tannin and lignin concentrations in the Peace River, 1988–89.

and grease that discharges from Petro Canada's refinery at Taylor, B.C. (Kathman and Cross 1989) amounts to less than 0.5 % of the load in the Peace River mainstem at the border. Mean oil and grease concentrations in the tributaries were within the range recorded for the mainstem (Fig. 54).

The ASWQO for oil and grease states that it should be "absent, no irridescent sheen", and the CWQG for recreational water quality states that it should not be detectable by sight or smell. No "sheens" or oil odours were apparent in surface water sampled during the synoptic surveys.

4.4.3 Phenolic Compounds

The term phenolic compounds refers to a family of organic compounds that possess a benzene ring, on which one or more hydroxyl groups are attached. The compound phenol consists of one benzene ring with one hydroxyl group. The benzene ring can undergo a variety of substitutions (McNeely et al. 1979). The analytical method used to determine phenolic concentrations is accurate in determining the quantity of the compound phenol, but not the quantity of all phenolic compounds present (Clesceri et al. 1989).

Phenolic compounds occur naturally in aquatic environments as a result of decomposition of aquatic plants and decaying vegetation. In addition, municipal and industrial effluents, especially pulp mills, discharge considerable amounts of phenolic compounds to surface waters. Phenolics are of concern because of their propensity to taint fish, to cause taste and odour problems in drinking water, and at high concentrations to be toxic to aquatic life.

In the Peace River at Dunvegan, phenolic concentrations were often below the detection limit of 0.001 mg/L, so the relationship between concentration and discharge could not be assessed. There were no significant seasonal or long-term trends in phenolic concentrations

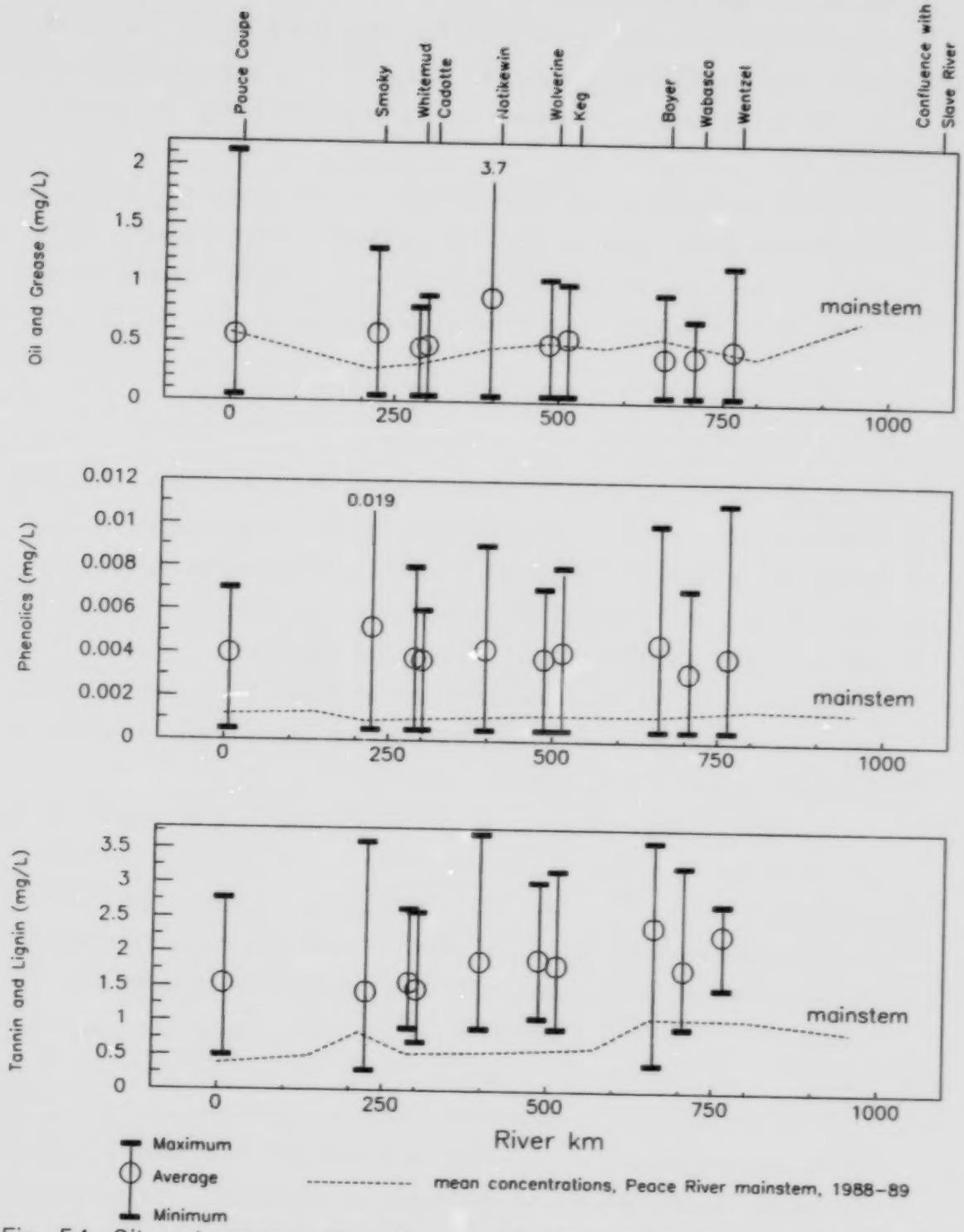


Fig. 54. Oil and grease, phenolics, and tannin and lignin concentrations in tributaries to the Peace River, 1988–89.

(Tables 7, 8).

Similar to oil and grease, concentrations of phenolics were relatively constant along the Peace River in 1988-89; average values ranged from 0.001 to 0.0015 mg/L (Fig. 53). Concentrations in the tributaries were approximately four-fold higher than the mainstem (Fig. 54), likely reflecting the natural phenolics associated with northern brownwater streams. The highest concentration was observed in the Smoky River, probably as a result of high phenolic loads from the Procter and Gamble pulp mill (Table 9; Noton et al. 1989). Input of phenolics from the Smoky River was not sufficient to noticeably increase phenolics at the next downstream site in the Peace River, although local increases in the Smoky River mixing zone would likely occur. At the mainstem sites and tributaries sampled during 1988-89, concentrations of phenolics were often non-compliant with the CWQG for freshwater aquatic life of 0.001 mg/L and occasionally non-compliant with the ASWQO of 0.005 mg/L. Except for the Smoky River, these high concentrations were attributable to natural processes rather than point source loads from industrial or municipal effluents (Table 9). Historical phenolic data are restricted to a few sites on the mainstem and one site on the Smoky River. Similar to the survey data, phenolic concentrations were often non-compliant with the CWQG and occasionally non-compliant with the ASWQO.

4.4.4 Tannin and Lignin

Tannin and lignin are constituents of plant matter and are ubiquitous in the aquatic environment as a result of decaying vegetation (CCREM 1987). Lignin is the compound primarily responsible for the rigidity of wood and is not differentiated from tannin in the analytical test; thus, concentrations are reported as tannin and lignin. In particular, lignin is of interest because it imparts a brown colour to bleached kraft pulp mill effluent, which is aesthetically objectionable and may reduce photosynthesis in the receiving water by reducing the

transmission of light (Parker and Sibert 1972).

There are no historical tannin and lignin data for the Peace River mainstem. Inspection of the synoptic survey data revealed no consistent seasonal pattern in concentrations of tannin and lignin. During 1988-89, mean concentrations of tannin and lignin increased along the mainstem from 0.4 mg/L at the B.C.-Alberta border to 1.1 mg/L at Ft. Vermilion (Fig. 53). Mean concentrations in the tributaries were approximately twice as high as the mainstem (Fig. 54), and concentrations were highest in the northern tributaries, likely reflecting their drainage from peatlands. There are no ASWQO or CWQG for these compounds.

4.4.5 Trace Organic Compounds

4.4.5.1 Pesticides

Pesticides and their derivatives have been monitored in surface waters of the Peace River system by Environment Canada and Alberta Environment since 1971 (Appendix VIII). Of the 41 compounds analyzed, only five have been detected in surface water samples (Table 10). The only insecticides detected were lindane (γ-BHC) and α-BHC. Lindane is used for controlling ticks and flies on livestock, seed treatment for wireworm control, and for controlling insect infestations of stored logs (Gummer 1979). α-BHC, on the other hand, has few or no insecticidal characteristics and is not an active ingredient in any present pesticide product. Rather, it is an impurity (< 1%) in the lindane product. However, prior to 1972, a pesticide (BHC) was used that contained 60 to 70 % α-BHC.

Lindane was detected at trace amounts (0.001 μg/L) in two samples from the Smoky River and three from the Peace River mainstem (Table 10). In contrast, α-BHC was detected at concentrations as high as 0.01 μg/L in most samples analyzed. α-BHC has been detected in other surface

Table 10. Maximum concentration (in μg/L) for pesticides detected in surface waters in the Peace River system. The values in brackets indicate the number of detections over the number of samples analyzed.

Compound	Detection Limit	Smoky River	Peace River	
			Dunvegan	Ft. Vermilion
α-BHC	0.001	0.01 (29/41)	0.008(34/40)	n/a
Lindane	0.001	0.001(2/47)	0.001(3/44)	b.d.(0/8)
2,4-D	0.004[1]	0.01 (2/47)	0.05 (2/42)	0.07 (1/6)
2,4,5-T	0.002[2]	0.004(2/47)	0.009(1/42)	0.001(1/6)
MCPA	0.2[3]	1.0 (1/47)	b.d.(0/44)	b.d.(0/4)

n/a not analyzed, b.d. - all values below detection limit.

[1]1972 to 1987; 1988 to 1989 detection limit was 0.03.

[2]1972 to 1987; 1988 to 1989 detection limit was 0.05.

[3]1977 to 1987; 1988 to 1989 detection limit was 0.03.

waters in western Canada in quantities greater than would be expected on the basis of past use and impurity levels in present lindane products (Gummer 1979). Atmospheric deposition and the isomerization of lindane to α-BHC (Benezet and Matsumura 1973) may explain the higher than expected concentrations of α-BHC.

Concentrations of α-BHC in the Peace River at Dunvegan followed no seasonal patterns (Table 7), although they have decreased significantly since 1977 (Fig. 55). This decrease in concentration suggests that the use of lindane is decreasing in the Peace River Basin, although quantitative data on lindane usage are not available. There are no ASWQO for either α-BHC or lindane and the CWQG for lindane pertains to drinking water.

Three herbicides have been detected in the Peace River system - 2,4-D, 2,4,5-T, and MCPA (Table 10). 2,4-D and MCPA are widely used on cereal crops for the control of broadleaf weeds and 2,4,5-T is used for brush control in pastures (Gummer 1979). The observed concentrations of 2,4-D and 2,4,5-T are within the lower range reported for surface waters in western Canada (CCREM 1987). However, of more than 400 samples analyzed for MCPA in western Canada from 1971 to 1977, it was not observed at concentrations above the analytical detection limit of 0.2 μg/L (Gummer 1979). The relatively high concentration reported for the Smoky River was recorded on 15 May 1984. That sample was also high in suspended solids (540 mg/L), and MCPA migrates rapidly from water to sediments (Gummer 1979). There are no ASWQO or CWQG for freshwater aquatic life for these herbicides.

4.4.5.2 Non-Pesticide Trace Organics

There is little historical, non-pesticide, trace organic data for the Peace River system. A few studies have examined the impact of effluents from the Procter and Gamble pulp mill on the Wapiti and Smoky rivers (Alberta Environmental Centre 1987; Noton et al. 1989). The only

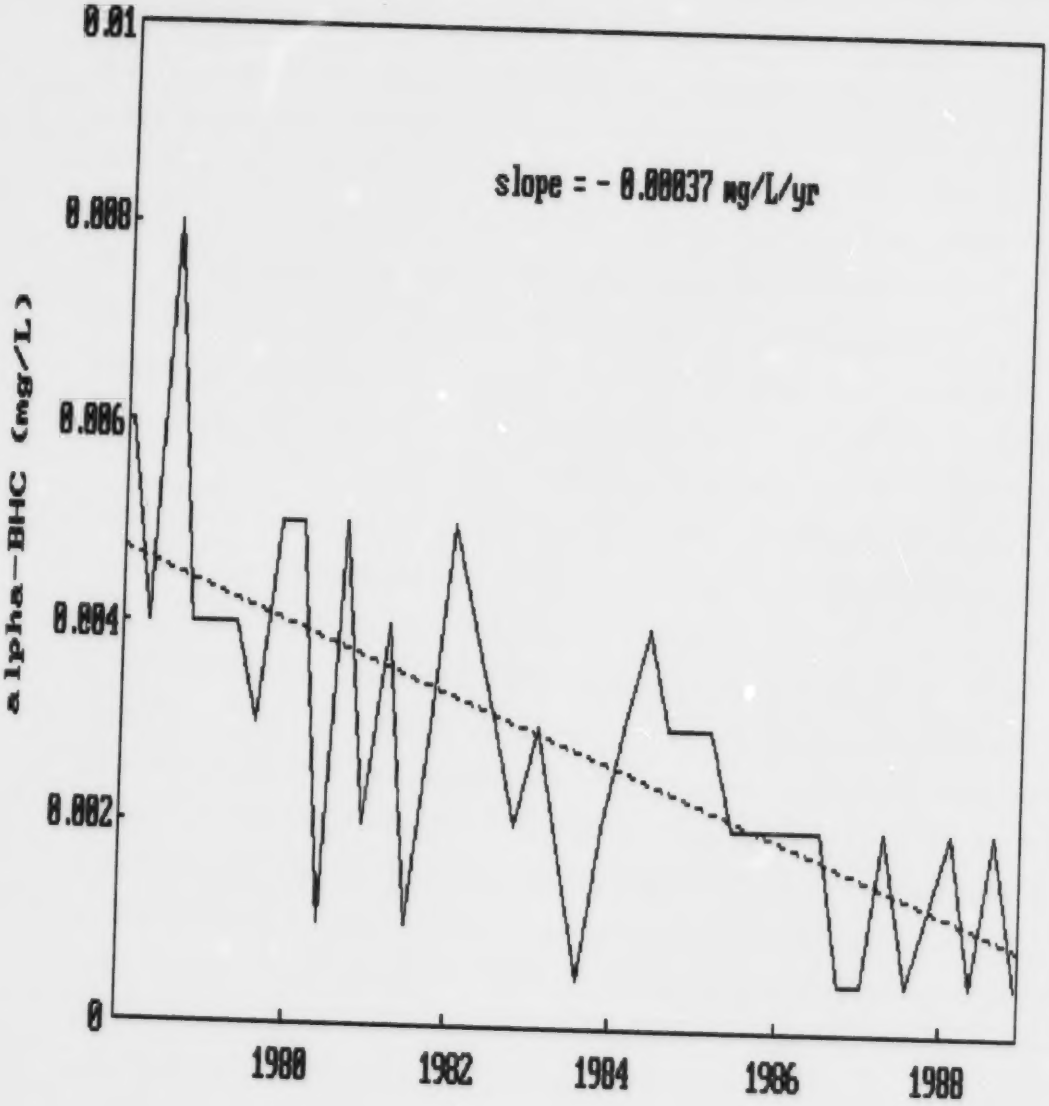


Fig. 55. Long-term trend in α-BHC concentrations in the Peace River at Dunvegan.

historical data for the mainstem are for polychlorinated biphenyls (PCB's), which were evaluated at the long-term monitoring stations on the Peace River (Dunvegan, Town of Peace River, and Ft. Vermilion) and Smoky River (Watino). Over 100 samples were analyzed from these sites during 1973 to 1989, and in all cases PCB concentrations were less than the detection limit, which varied from 0.002 to 0.6 μg/L. Chlorinated dioxins and furans have not been detected in raw or treated water from the Peace River mainstem (D. Spink, 1990, person. commun.). However, these compounds have been detected in benthic invertebrates and bottom sediments in the Wapiti River, downstream of the Procter and Gamble pulp mill effluent (Alberta Environment 1988).

In the May, August, and October 1988 and February-March 1989 surveys, sampling was carried out for total hydrocarbons, trace organic, non-pesticide "priority pollutants" (as identified by the United States Environmental Protection Agency - Appendix II), and a number of other extractable (semi-volatile) trace organic compounds.

Concentrations of hydrocarbons were below the detection limit of 0.05 mg/L in all surface water samples (Appendix V). Most of the 90 trace organic "priority pollutants" were not detected, but thirteen other trace organic compounds were tentatively identified in surface water during the 1988-89 synoptic surveys (Appendix V). However, the detection of the phthalate compounds, benzoic acid, hexadecanoic acid, and toluene were likely a result of sample contamination (Noton and Shaw 1989; EQMB unpublished data) and were considered to be false positives. The remaining compounds were detected at trace concentrations and further sampling would be necessary to determine whether the detections were real or due to sample contamination.

Three monocyclic aromatic hydrocarbons were tentatively identified in surface water samples - benzene, m,p-xylene, and 1,4-dichlorobenzene (Table 11). These compounds have industrial applications and are used in the production of pesticides; benzene and xylene are also present

Table 11. Trace organic compounds detected in surface waters of the Peace River Basin, 1988-89.

Site	2-Chloro-naphthalene	Phenol	Benzene	Chloroform	1,4-Dichloro-benzene	m,p-Xylene
PR at Border					T	
PR at Dunvegan			T			T
PR u/s Smoky		T				
Smoky R.				T		
PR u/s Whitemud R.			T			
PR at Manning(r)		T				
PR u/s Notikewin R.	T					
Notikewin R.	T					
PR at Ft. Vermilion			T			
Boyer R.	T					
Wabasca R.	T					

T - trace concentration, < 0.5 μg/L; blank - not detected; r -right bank.

in gasoline and other petroleum products (Verschueren 1983, Moore and Ramamoorthy 1984, CCREM 1987). They can be released into aquatic environments from point sources such as municipal effluents and urban runoff and non-point sources such as surface runoff from agricultural land and atmospheric deposition. Concentrations of these compounds in the effluents were low. If the values recorded in the river are not false positives, they may be a result of point-source loads elsewhere in the basin (i.e., unsampled effluents) and/or diffuse runoff from agricultural land. Concentrations of these compounds measured in the 1988-89 surveys were well below the CWQG for freshwater aquatic life of 300 and 4 μg/L for benzene and 1,4-dichlorobenzene, respectively. There are no CWQG for xylene.

2-Chloronaphthalene, a polycyclic aromatic hydrocarbon (PAH) was tentatively identified in surface water samples from one Peace River site and three tributaries (Table 11). PAH's are generated by the incomplete combustion of organic material, such as the burning of fossil fuels or forest fires. Atmospheric deposition is believed to be responsible for background levels of PAH's observed in surface waters (CCREM 1987). Concentrations of 2-chloronaphthalene in effluents were low or not detected, so if the presence of this compound was not a result of sample contamination, it was likely related to non-point sources. There are no CWQG for this compound.

Trace amounts of the compound phenol was tentatively detected in two samples from the Peace River mainstem (Table 11). Phenol occurs naturally in aquatic environments, because it is a decomposition product of aquatic plants and decaying vegetation (CCREM 1987). In addition, phenol is used to manufacture pesticides, so it may be transported to surface waters from runoff of agricultural land (Moore and Ramamoorthy 1984). For total phenols, the CWQG for freshwater aquatic life is 1 μg/L and the ASWQO is 5 μg/L. Values for phenol in the mainstem complied with these guidelines, although total phenols were often non-

compliant (Section 4.4.3).

Chloroform was detected in one sample from the Smoky River (Table 11). The primary source of chloroform in aquatic environments is from the reaction of chlorine with organic chemicals in effluents and raw municipal water (CCREM 1987); appreciable amounts of chloroform are often associated with effluent from bleached kraft mills (Bonsor et al. 1988). Concentrations of chloroform in the effluent from the Procter and Gamble bleached kraft pulp mill were relatively high (28 to 42 µg/L; Appendix V), and that effluent may have been the source of chloroform in the Smoky River. This result is consistent with that observed in a previous study of the impact of effluent from the Procter and Gamble mill on water quality of the Wapiti and Smoky rivers (Noton et al. 1989). There is no ASWQO for chloroform and the CWQG for total trihalomethanes (which includes chloroform) pertains to drinking water.

4.5 BIOLOGICAL VARIABLES

4.5.1 Bacteria

Bacteria are a diverse group of organisms that occur naturally in aquatic environments. These organisms may be single-celled, filamentous or colonial, are found in aerobic and anaerobic water, and include both heterotrophic (obtain energy from organic matter) and autotrophic (obtain energy from oxidation of inorganic compounds, e.g., iron or sulphur) forms. Bacteria that occur naturally in surface water are generally not pathogenic to humans (Clesceri et al. 1989). Pathogenic bacteria can, however, be introduced into surface waters from wastewater, particularly from municipal sewage effluents.

In the Peace River system, bacterial analyses have included standard plate counts for heterotrophic bacteria, and tests for total coliforms, fecal coliforms, and fecal streptococci. The coliform group comprises all aerobic and facultative anaerobic, gram-negative, non-

spore forming, rod-shaped bacteria that ferment lactose, with gas and acid formation within 45 h at 35 ^{o}C (Clesceri et al. 1989). Total coliforms include heterotrophic bacteria of both fecal and non-fecal origin. The main use of the total coliform test is to check treated drinking water (Health and Welfare Canada 1987). The fecal coliform test is used to differentiate between coliforms of fecal origin (those originating in the intestine of warm-blooded animals) and coliforms from other sources. Analysis of fecal coliforms in Canadian surface waters indicates that Escherichia coli usually comprises a high portion of the count (CCREM 1987). In addition to E. coli, bacteria that are not of fecal origin, such as Klebsiella sp., show up in counts of fecal coliforms. Klebsiella are common in organically rich water such as pulp and paper mill effluents (Poole et al. 1978). In the aquatic environment, Klebsiella are not considered to be pathogenic (Duncan 1988). Fecal coliform counts have been used as a fecal pollution indicator for many years because of the ease of measurements. However, the counts do not correlate well with the incidence of gastro-intestinal (GI) illness, and the use of this group is being phased out (CCREM 1987). The normal habitat for fecal streptococci is the GI tract of warm-blooded animals. The ratio of fecal coliforms to fecal streptococci has been used to provide information about the source of bacterial contamination. However, the use of this ratio is no longer recommended (Clesceri et al. 1989).

In the Peace River at Dunvegan, total coliform counts were independent of flow (Table 6) and followed no consistent seasonal pattern (Table 7). However, during the synoptic surveys, bacterial counts tended to be highest in July and lowest in February-March. There were no long-term trends in fecal or total coliforms (Table 8), but there was a significant increase in counts of fecal streptococci from 1978 to 1988 (Fig. 56). The cause of the increase is not known; it was

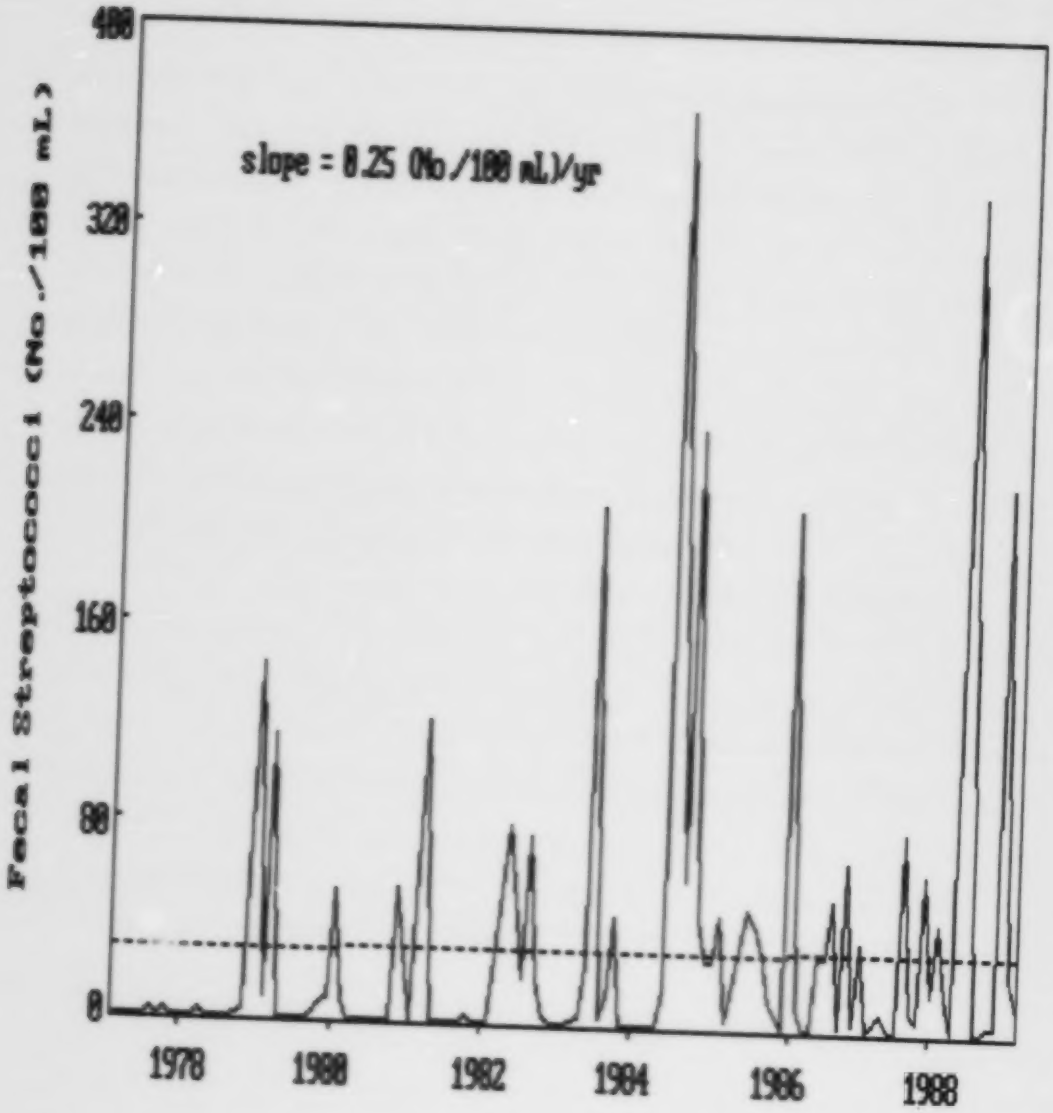


Fig. 56. Long-term trend in fecal streptococci counts in the Peace River at Dunvegan.

probably not related to increased municipal sewage loads since there was no concurrent increase in fecal coliform counts.

The most conspicuous feature of the longitudinal pattern for mean bacterial counts along the mainstem in 1988-89 was the increase immediately downstream of the Town of Peace River (Fig. 57). The increase in coliforms may be a result of the high coliform loads associated with sewage from the Town of Peace River, which only provides primary wastewater treatment (Table 9). The load from the Smoky River was also high, but mean counts in the Smoky River were actually lower than in the mainstem (Fig. 58). The increase in heterotrophic bacteria was largely a result of loading from the Smoky River, perhaps due in part to effluent discharge from the Procter and Gamble pulp mill (Table 9; Noton et al. 1989). With the exception of high heterotrophic bacteria counts in the Smoky River and low fecal coliform counts in the Smoky and Wabasca rivers, mean bacterial counts in the tributaries were similar to the mainstem (Fig. 58).

For potable supply to water treatment facilities and non-contact recreation, the ASWQO for coliform bacteria states that for $\geq$ 5 samples within a 30 day period, 90 % of samples should have < 5000/100 mL total coliforms and < 1000/100 mL fecal coliforms. The CWQG for recreational water quality for fecal coliforms is that the geometric mean of not less than 5 samples in a 30 day period is < 200/100 mL. The CWQG for total coliforms (10/100 mL) pertain only to drinking water. No total or fecal coliform counts measured in surface water during the synoptic surveys exceeded 5000/100 mL or 1000/100 mL, respectively, and only two samples for fecal coliforms exceeded 200/100 mL.

4.5.2 Algal Chlorophyll-a

Phytoplankton, those algae found in the water column, are normally present in major rivers. Phytoplankton in rivers (potamo-phytoplankton) are generally believed to be derived from the benthos and/or inocula

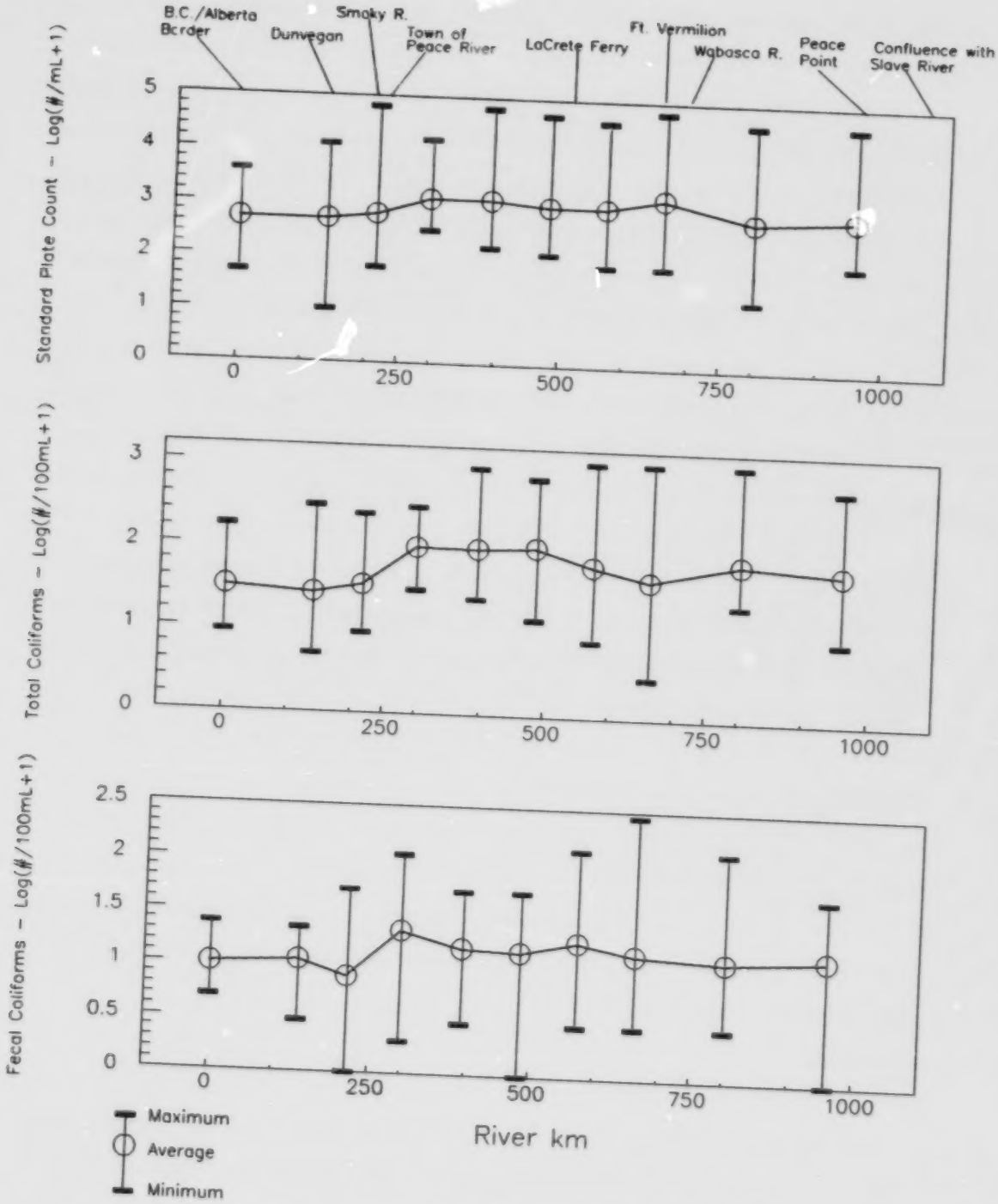


Fig. 57. Bacterial counts along the Peace River, 1988–89.

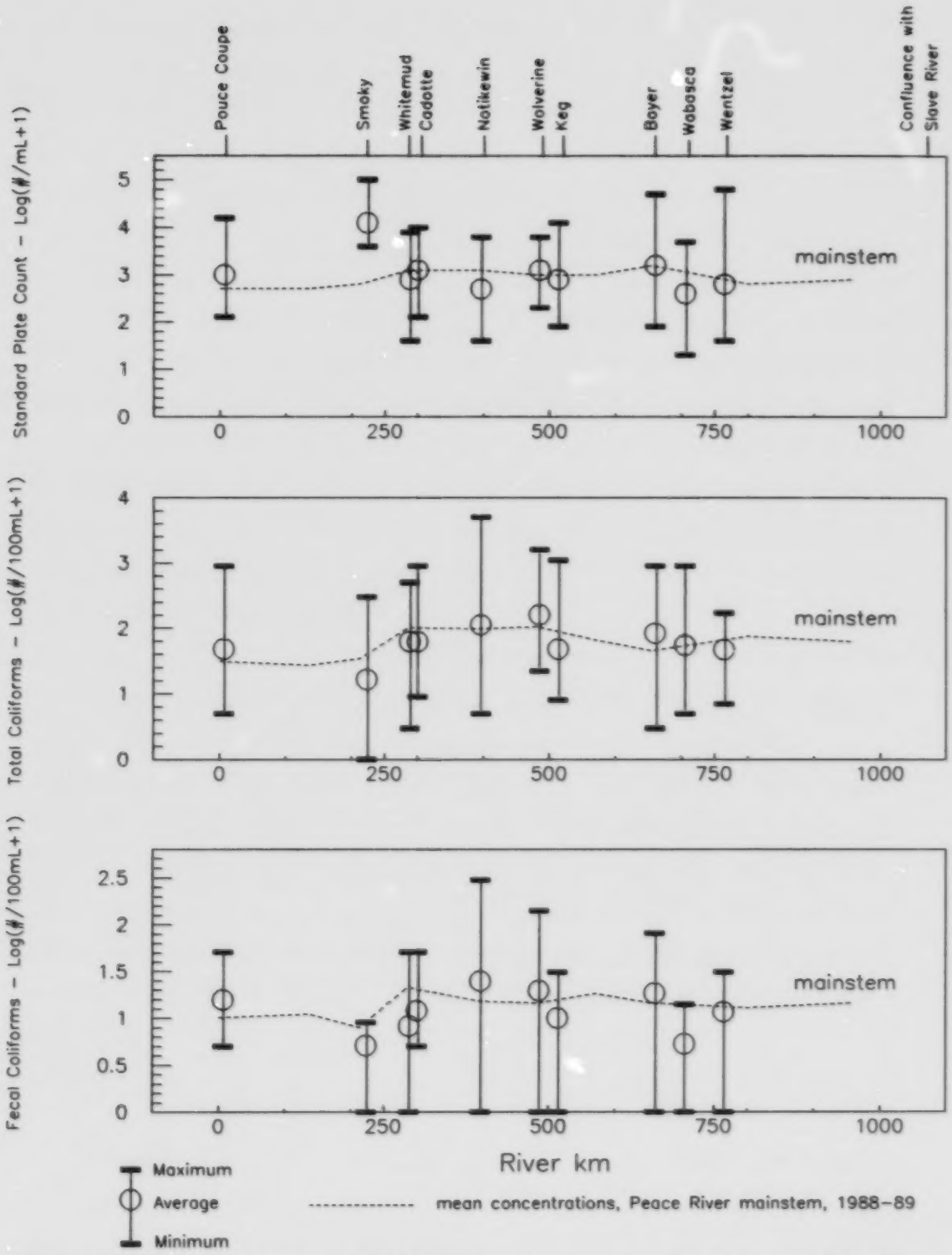


Fig. 58. Bacterial counts in tributaries to the Peace River, 1988–89.

from lakes or pond-like side arms of the river (Whitton 1975). Epilithic algae (periphyton) are those algae that are attached to the bottom substrate of the river. Unlike potamo-phytoplankton, which may not respond fully to the influence of point-source pollution for a considerable distance downstream, periphyton may show dramatic quantitative and qualitative responses immediately below pollution sources (Clesceri et al. 1989). Qualitative data on algal composition are not available for the Peace River system, and quantitative data are limited to chlorophyll-a values measured during the synoptic surveys. Chlorophyll-a is a photosynthetic pigment found in most algae. Concentrations of chlorophyll-a are generally correlated to algal biomass and, thus, are an estimate of the standing crop of algae.

In 1988-89, planktonic chlorophyll-a concentrations were generally lowest in winter (February-March) and highest in late summer (August to September). Mean concentrations declined from just over 2 μg/L at the B.C.-Alberta border to 1.8 μg/L upstream of the Whitemud River, with the exception of a peak at Dunvegan (Fig. 59). The peak at Dunvegan was an artifact of one high data point (15.7 mg/L), which was coincident with a high concentration of suspended solids. Mean concentrations of chlorophyll-a were relatively constant along the mainstem from the Whitemud River to Ft. Vermilion and then increased to approximately 3 μg/L at Peace Point. Chlorophyll-a concentrations in the tributaries were highly variable; mean concentrations ranged from 1 μg/L in the Smoky River to 19.5 μg/L in the Wolverine River (Fig. 59).

Epilithic chlorophyll-a values were measured in the mainstem only, during four of the seven synoptic surveys. They were not measured downstream of Ft. Vermilion because of the lack of suitable substrate (i.e., rocks) at the sampling sites. Epilithic chlorophyll-a values were highly variable and ranged from 1.0 to 99 mg/m^2, although values tended to decrease along the length of the river (Fig. 60). This spatial pattern may be related to the increased suspended solid

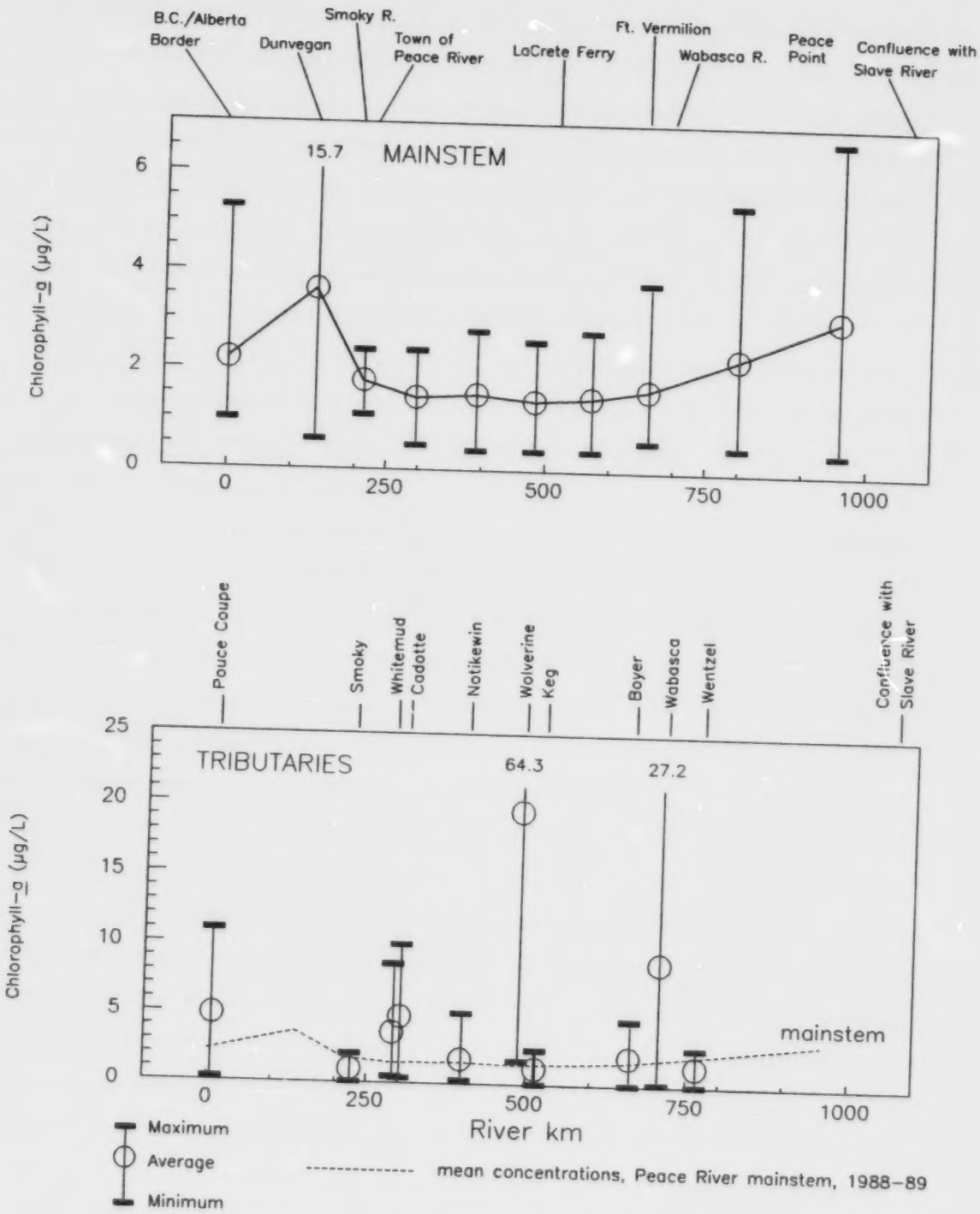


Fig. 59. Planktonic chlorophyll–a in the Peace River system, 1988–89.

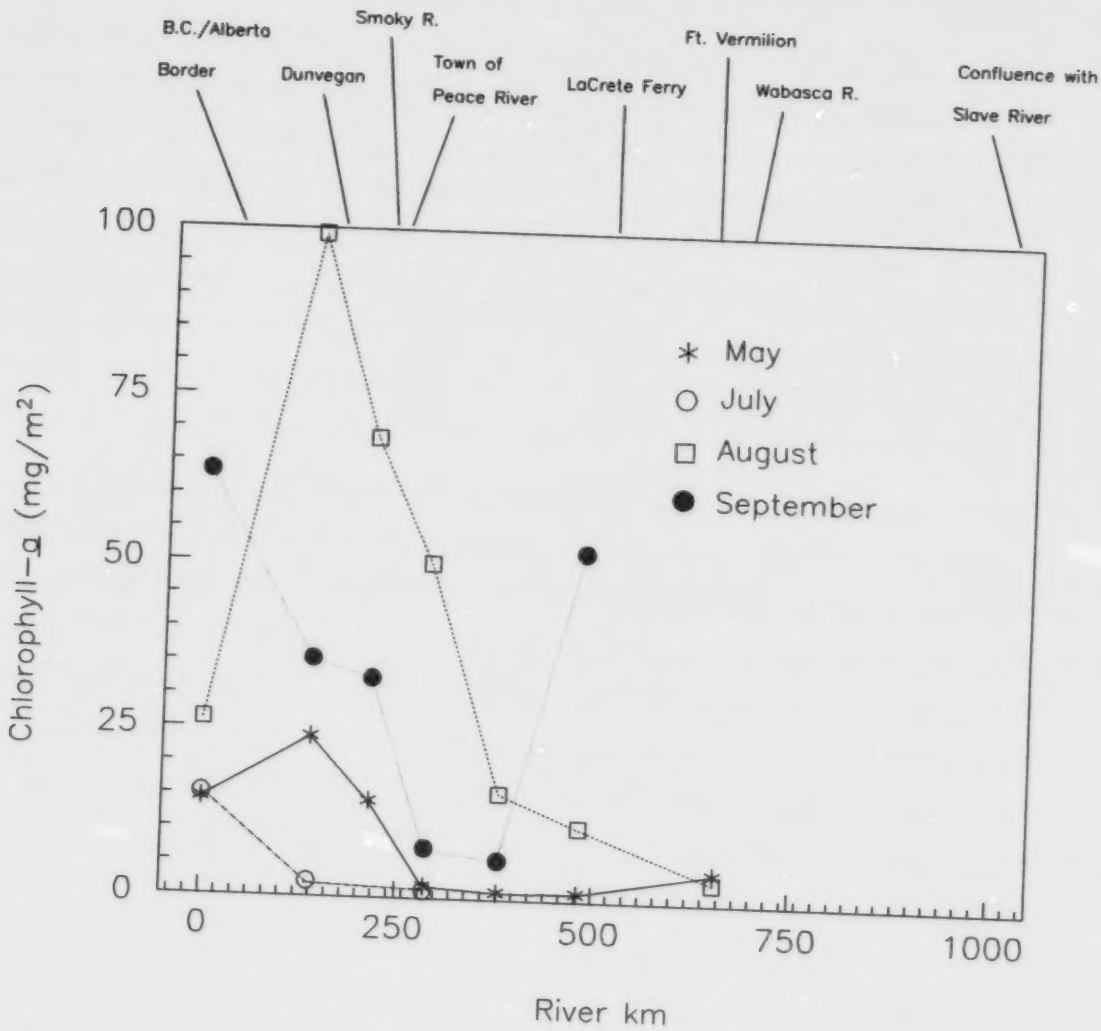


Fig. 60. Epilithic chlorophyll-a values in the mainstem, 1988.

concentrations and turbidity along the mainstem. A similar pattern in epilithic chlorophyll and suspended solids concentrations has been observed in the Athabasca River (Hamilton et al. 1985). In the Peace River, the lowest values were measured in July 1988, perhaps as a result of scouring of the periphyton by the high suspended solids content and/or because the rocks that were sampled during high flows were only recently colonized. In general, the highest values were recorded in August, probably as a result of the relatively clear waters (i.e., low turbidity) and warm water temperatures. There are no ASWQO or CWQG for planktonic or epilithic chlorophyll-a.

4.5.3 Zoobenthos

The Environmental Quality Monitoring Branch has conducted benthic macro-invertebrate (zoobenthos) surveys in the Peace River since 1987. Samples were collected from near the B.C.-Alberta border, the site of the Daishowa pulp mill downstream of the Town of Peace River, and 10 sites along the mainstem from the B.C.-Alberta border to Peace Point (Table 2). The following description of the Peace River zoobenthos focuses primarily on data from one synoptic survey conducted in September-October 1988, and its prime objective is to document major longitudinal trends in the river's zoobenthos.

Physical habitat characteristics measured at each sampling site are given in Appendix IX and the zoobenthos data are in Appendix X. Sampling depth was similar among synoptic survey sites. However, there were considerable longitudinal changes in substrate: cobble was most abundant in the upper reach (B.C.-Alberta border to upstream of the Whitemud River), pebble at the Notikewin River and Carcajou sites, and sand in the lower reach (LaCrete to Peace Point). The composition of the river bed at the sampling sites appears to be fairly representative of the substrate conditions along the river (Section 3.2). Flow velocity was noticeably lower in the lower reaches of the river.

4.5.3.1 Number of Taxa and Total Invertebrate Numbers

A diverse assemblage of benthic invertebrates was collected in the Peace River in 1987 and 1988; a total of 106 taxa was recorded in the 230 samples collected during these two years (Table 12). The mean number of invertebrate taxa per sample ranged from 4.4 (upstream Wood Buffalo National Park, fall 1988) to 27.8 (upstream Clear River, summer 1988) (Fig. 61 to 63). The mean number of taxa recorded in the synoptic survey samples ranged from 4.4 (upstream Wood Buffalo National Park) to 23.6 (upstream Whitemud River, left bank) (Fig. 61). The mean number of taxa exceeded 11 at Carcajou and all sites further upstream, but was below 9 at all sites further downstream.

Total invertebrate numbers ranged from a mean of 17 specimens per sample, upstream of Wood Buffalo in fall 1988, to a mean of 2295 specimens per sample at the B.C.-Alberta border left bank site in fall 1988 (Fig. 61 to 63). There was a decline of total invertebrate numbers along the mainstem (Fig. 61). At sites from the B.C.-Alberta border to the Whitemud River, mean numbers generally exceeded 400 specimens per sample. At the Notikewin, Carcajou, and LaCrete sites, numbers dropped below 200 specimens per sample, and at the three most downstream sites numbers were less than 50 specimens per sample (Fig. 61). Invertebrate population densities in the Peace River were low compared to those recorded in more productive rivers in southern Alberta, such as the North Saskatchewan River where invertebrate numbers usually exceed 1000 per sample (Anderson 1986).

4.5.3.2 Dominant Taxa

Dominant taxa in the Peace River zoobenthos were Oligochaeta (bristle worms), Chironomidae larvae (midge larvae), and Nematoda (round worms). At most sites these three taxa comprised at least 50% of the total invertebrate numbers (Fig. 64). The downstream decline in numbers

Table 12. Invertebrate taxa identified in the Peace River, 1987-88.

Coelenterata
- Hydridae

Nematoda

Turbellaria

Oligochaeta
- Tubificidae
- Naididae
- Enchytraeidae
- Lumbriculidae

Crustacea
- Cyclopoida
- Calanoida
- Harpacticoida
- *Bosmina*
- Bosminidae
- Chydoridae
- *Daphnia*
- Daphnidae
- Calanoida

Ephemeroptera
- *Ameletus*
- *Baetis*
- Baetidae
- *Caenis*
- Caenidae
- *Cinygmula*
- *Ephemerella*
- Ephemerellidae
- Ephemeroptera imm.
- *Isonychia*
- *Heptagenia*
- Heptagenidae
- *Leptophlebia*
- *Paraleptophlebia*
- *Rhithrogena*
- Siphlonuridae
- *Stenonema*
- *Tricorythodes*

Trichoptera
- *Arctopsyche*
- *Brachycentrus*
- *Cheumatopsyche*
- *Ceraclea*
- *Glossosoma*
- *Hydroptila*
- Hydroptilidae
- Hydrophilidae
- Hydropsychidae
- Hydropsyche
- *Lepidostoma*
- *Oecetis*
- Trichoptera imm.

Plecoptera
- *Amphinemura*
- Capniidae
- *Claassenia sabulosa*
- Chloroperlidae
- *Hesperoperla*
- *Isogenoides*
- *Isoperla*
- *Malenka*
- Nemouridae
- *Oemopteryx*
- Perlidae
- Perlodidae
- *Pteronarcella*
- *Podmosta*
- Plecoptera imm.
- *Skwala*
- Suwallia complex
- Taeniopterygidae
- *Zapada*

Collembola

Coleoptera
- Carabidae
- Curculionidae
- Dryopidae
- Dytiscidae

Hemiptera
- Corixidae
- Saldidae

Diptera
- Chironomidae
  - Chironominae
  - Chironomid pupae
  - Diamesinae
  - Orthocladiinae
  - Tanypodinae
  - Tanytarsini
  - Prodiamesinae
- Tipulidae
  - *Dicranota*
  - *Limnophila*
- Rhagionidae = Athericidae
  - *Atherix*
- Empididae
  - *Clinocera*
  - *Chelifera*
  - *Hemerodromia*
- Tanyderidae
  - *Protanyderus*
- Simuliidae
- Ceratopogonidae

Diptera (cont'd)
- Muscidae
- Dolichopodidae
- Diptera adults
- Diptera pupae

Arachnida
- Acari
- Aranea

Mollusca
- *Lymnea*

Tardigrada

Terrestrial Insects

imm. - immature

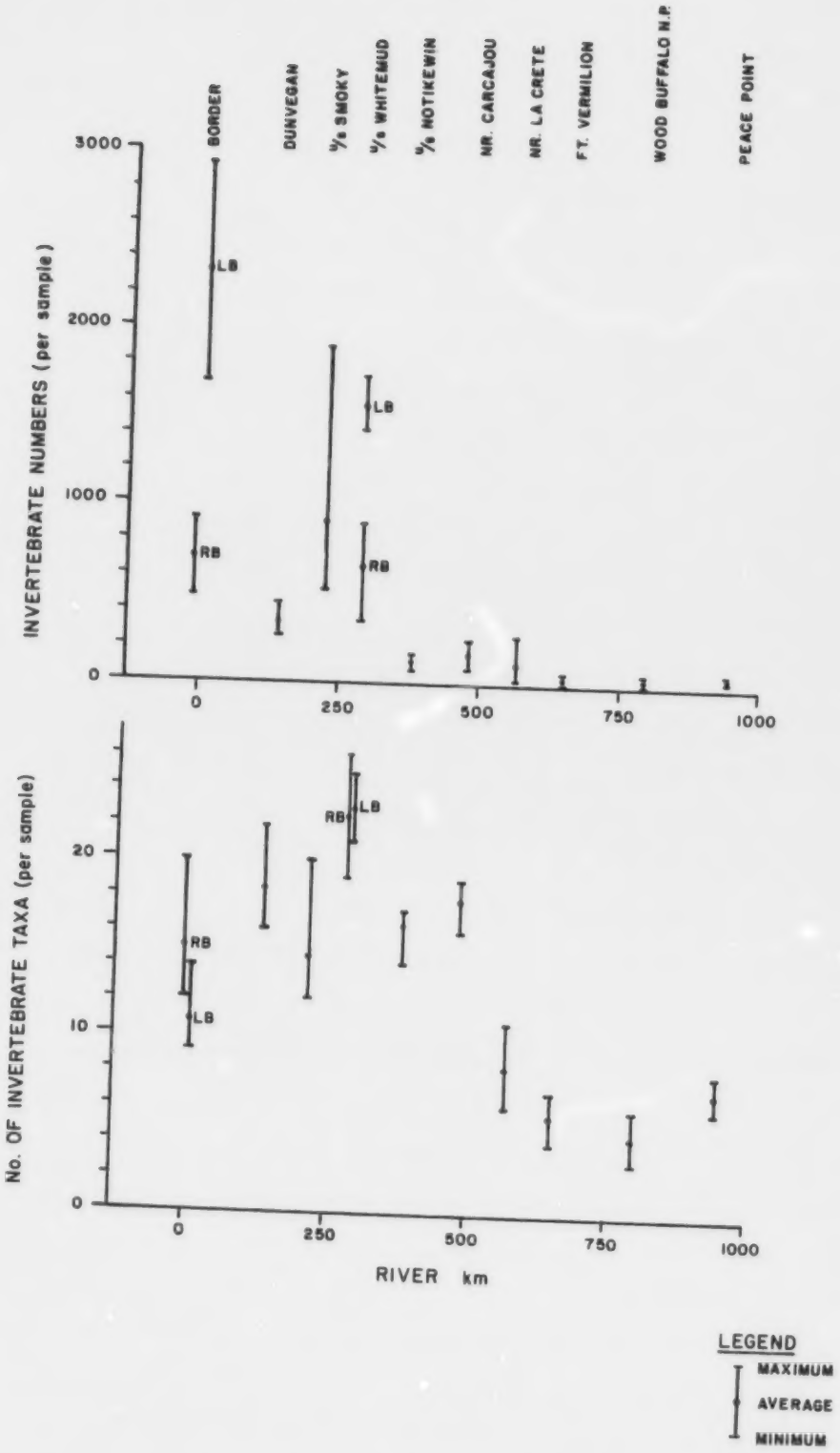


Fig. 61. Total invertebrate numbers and number of invertebrate taxa per sample in the Peace River, September - October 1988.

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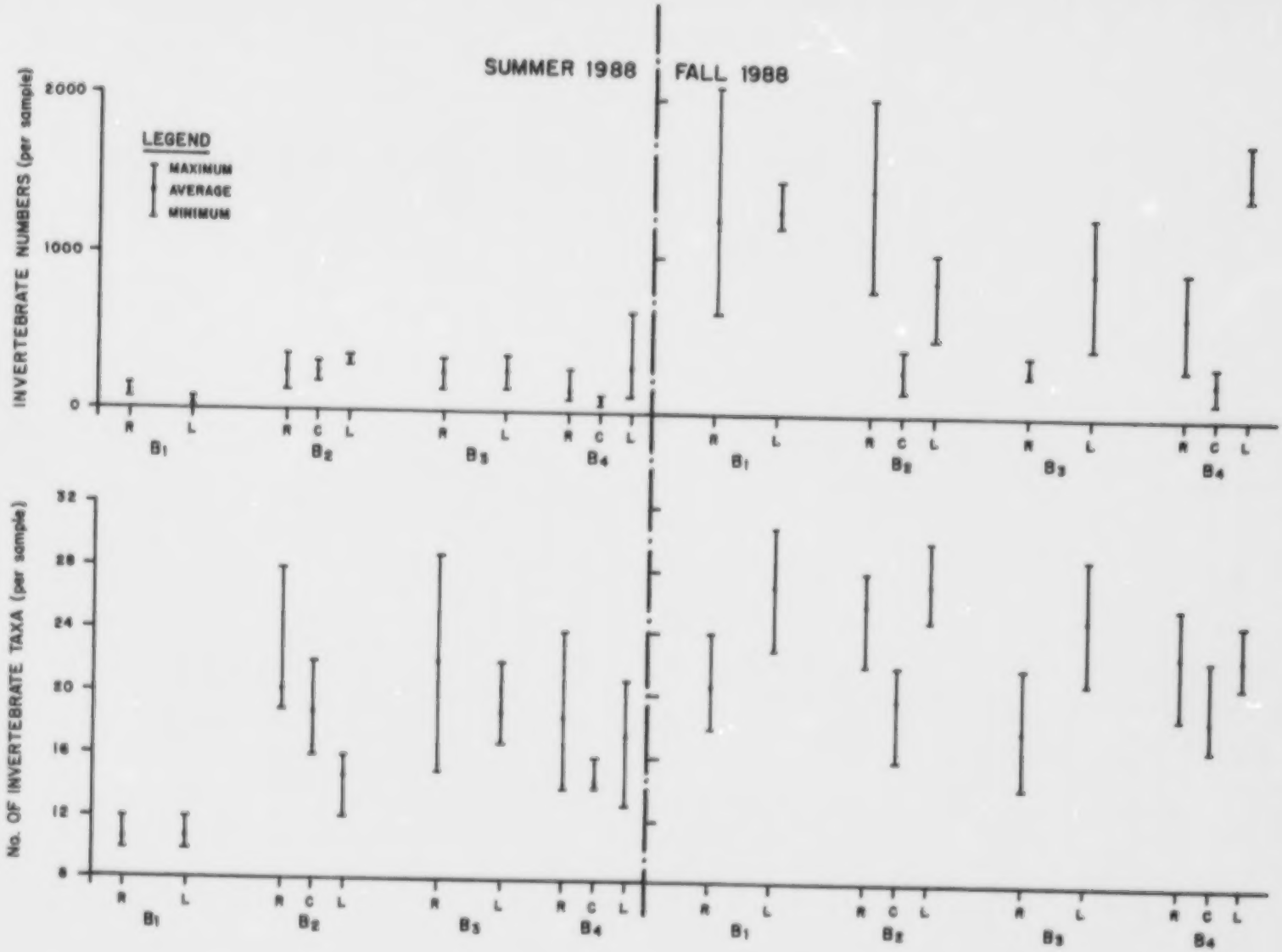

Fig. 62. Total invertebrate numbers and number of invertebrate taxa per sample in the Peace River near the Daishowa site, summer and fall 1988, (refer to Figure 3 for site labels).

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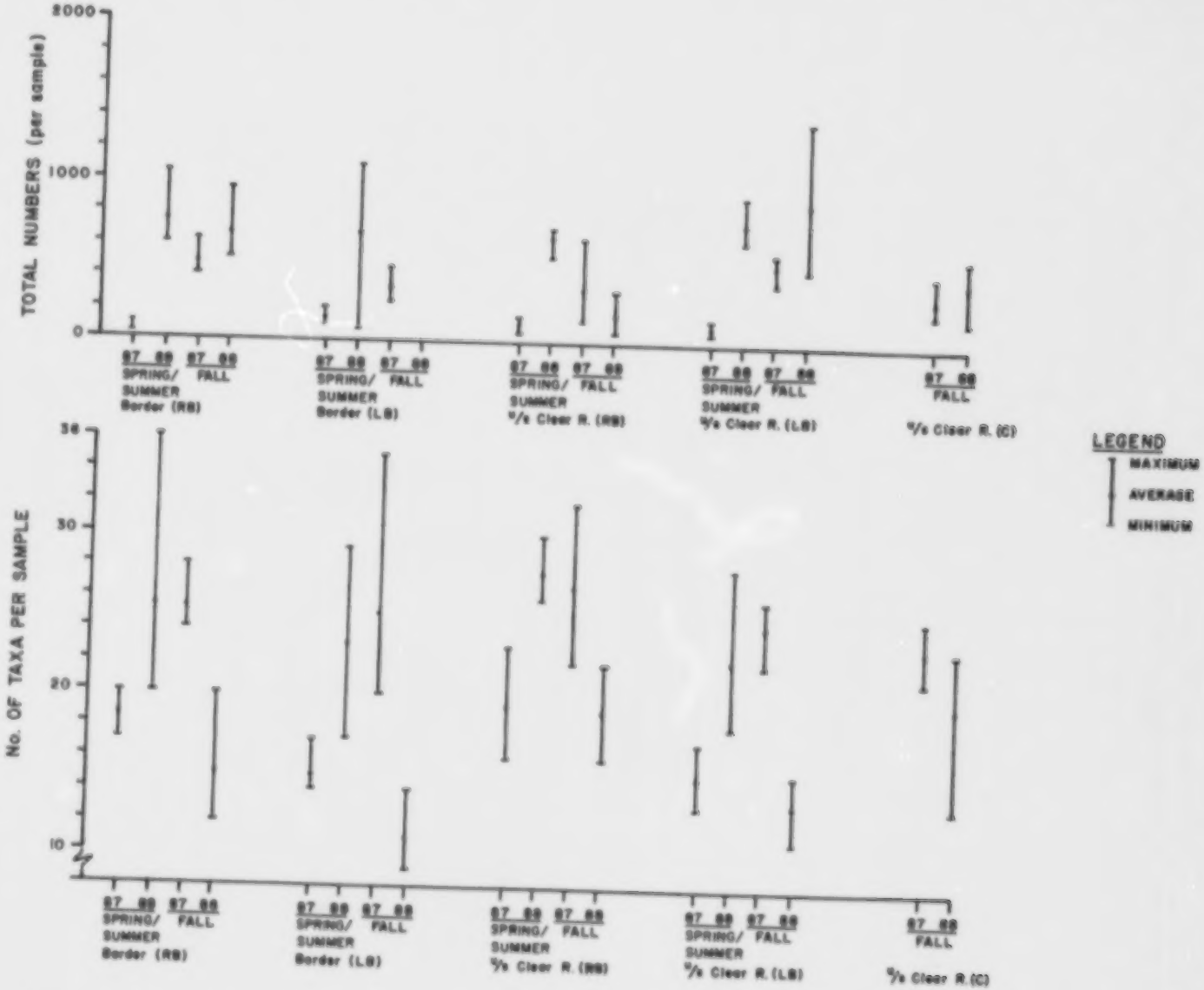

Fig. 63. Total invertebrate numbers and number of invertebrate taxa per sample in the Peace River near the B.C. - Alberta border, spring and fall 1987 and summer and fall 1988.

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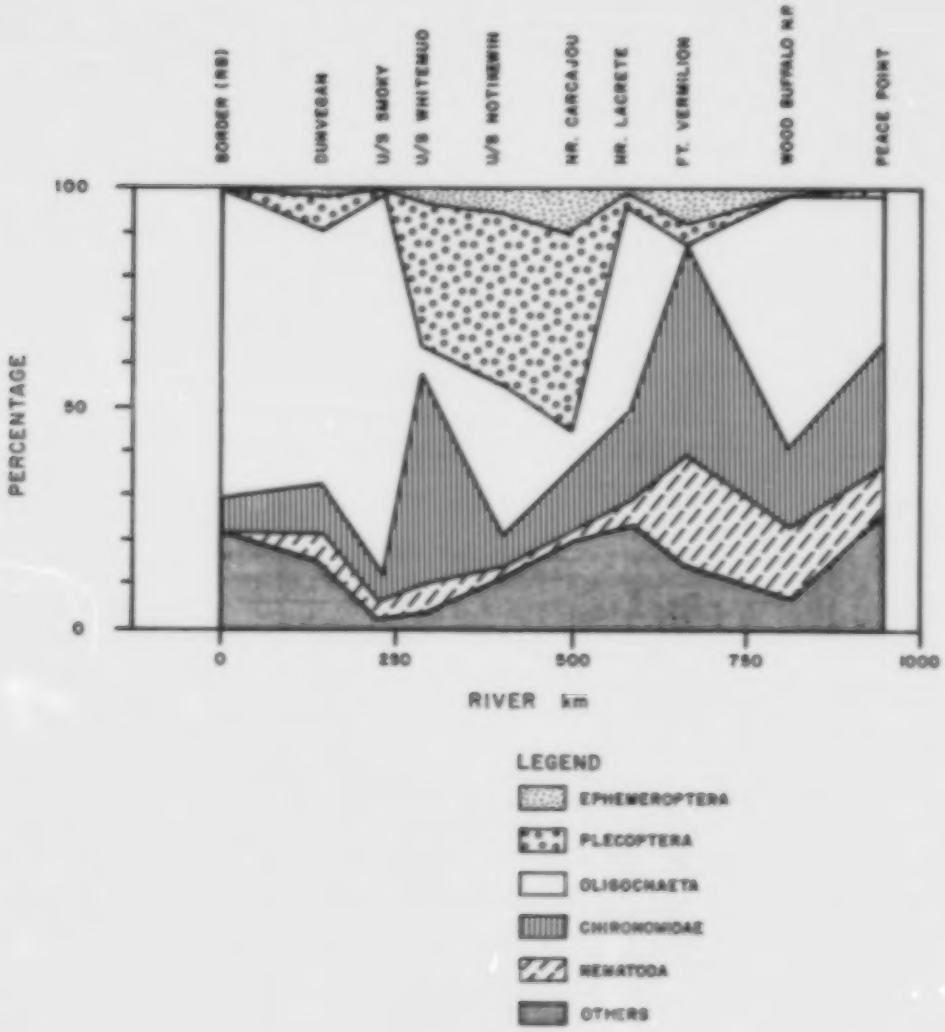

Fig. 64. Percent contribution of major taxonomic groups to total invertebrate numbers in the Peace River, September - October 1988.

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of Nematoda and Chironomidae was relatively smaller than that of other taxa; proportions of these two groups tended to increase downstream.

Chironomini and Orthocladiinae, the numerically dominant Chironomidae larvae, were encountered at all sites in the Peace River. They were most abundant at the two sites (i.e. left and right bank) upstream of the Whitemud River. Tanytarsini and Tanypodinae were common upstream of the Whitemud River, but they were not encountered downstream of LaCrete. Highest numbers of Tanytarsini were encountered on the left bank, upstream of Whitemud River. Diamesinae and Prodiamesinae were encountered occasionally, always in low numbers.

Enchytraeidae and Naididae were the most abundant Oligochaeta at the B.C.-Alberta border sites, and their numbers declined gradually along the mainstem. Tubificidae were also most abundant at the upstream sites, but contrary to the other families they were not encountered at any of the sites sampled downstream of the Whitemud River confluence.

Trichoptera (caddisfly larvae) were neither abundant nor diverse in the Peace River samples. Only two families (Hydropsychidae and Brachycentridae) and three genera (Hydropsyche, Cheumatopsyche and Brachycentrus) were recorded in samples collected during the synoptic survey. The additional Trichoptera listed in Table 12 occurred in samples collected near the B.C.-Alberta border.

Ephemeroptera (mayflies) were slightly more abundant than caddisflies. Dominant mayflies included Baetidae (Baetis), Heptageniidae (Heptagenia, Rhithrogena) and Ephemerellidae (Ephemerella). These taxa were most important at sites between and including Dunvegan and Carcajou, albeit absolute numbers were generally low (Fig. 64). Isonychia, one of the few mayflies with predatory habits (Merritt and Cummins 1984) was the only mayfly encountered downstream of LaCrete. Other mayflies listed in Table 12 were from samples collected near the B.C.-Alberta border.

Plecoptera larvae (stoneflies) were an important component of the

zoobenthos at the sites upstream of the Whitemud River, upstream of the Notikewin River, and near Carcajou where they represented 30% or more of the total numbers (Fig. 64). Dominant stoneflies in these samples were Perlodidae such as Isoperla, Isogenoides, and immature specimens; Taeniopterygidae (including Oemopteryx and immature specimens) were most abundant at the site upstream of the Whitemud River. Several other stonefly genera were encountered near the B.C.-Alberta border.

Other invertebrate groups encountered in the Peace River zoobenthic samples included Hydrozoa, Acari, and Crustacea (i.e., copepods and cladocerans). These taxa represented jointly less than 20% of the total numbers (Fig. 64).

4.5.3.3 Temporal Variability

Spring, fall, and some summer data are available for the border sites and for the sites in the vicinity of the future pulp mill near the Town of Peace River. Such data are insufficient to describe seasonal changes in the zoobenthos in detail, but they can provide some indication of overall changes at the community level. Seasonal patterns were more apparent in the mean total number of invertebrates, which tended to be low in spring and high in fall, than in the number of taxa, which did not show any consistent seasonal trend (Fig. 61 to 63). Numbers of invertebrates collected in the vicinity of the future pulp mill were nearly an order of magnitude lower in the summer of 1988 than in the fall of the same year (Fig. 62). However, numbers at the border sites were rather similar in summer and fall 1988 (Fig. 63).

4.5.3.4 Multivariate Analysis

Cluster analysis (CA) and principal components analysis (PCA) were performed on zoobenthic data from fall 1988 in an attempt to identify groups of sites with similar zoobenthic associations. Cluster analysis

divided the Peace River sites into three groups (Fig. 65B):

- Cluster I - left and the right bank samples upstream of the Whitemud River;
- Cluster II - all sites upstream of these two sites;
- Cluster III - all sites downstream of the Whitemud River. This cluster splits into two sub-clusters, one of which consists of the Notikewin and Carcajou sites and the other is made up of the four most downstream sites (LaCrete, Fort Vermilion, Wood Buffalo National Park, and Peace Point).

The site groupings obtained by CA (Fig. 65B) were compatible with the results obtained with PCA (Fig. 65A). The first three principal components explained 53.4% of the total sample variance. The first component accounted for 28.5% of the variance and separated the first cluster defined in CA from all other site groups, primarily because these two sites were typified by relatively high overall densities of stoneflies (e.g., Isoperla, Oemopteryx, or Perlodidae), mayflies (e.g., Heptageniidae, Baetidae, or Rhithrogena), chironomid larvae (e.g., Orthocladiinae, Tanypodinae, and Tanytarsini), mites (acari), and some Diptera larvae (e.g., Hemerodromia).

The second component explained 13.4% of the sample variance and differentiated the Notikewin and Carcajou sites from the remaining sites because of the relative abundance of stoneflies (e.g., Taeniopterygidae, Isogenoides, Capniidae, and immature stoneflies), mayflies (Ephemerella), crustaceans (Calanoida, Cyclopoida, Bosminidae) and Hydridae.

The third component explained 11.6% of the variance and differentiated the lower and upper reach sites. Lower reach sites were typified by the presence of Isonychia (Ephemeroptera) and by low numbers of most other taxa including Enchytraeidae, Naididae, Tubificidae, Nematoda, Orthocladiinae, Diamesinae, Hydridae and Calanoida, which were also typical of the upper reach sites.

Further discussion of the zoobenthos is included in Section 5.

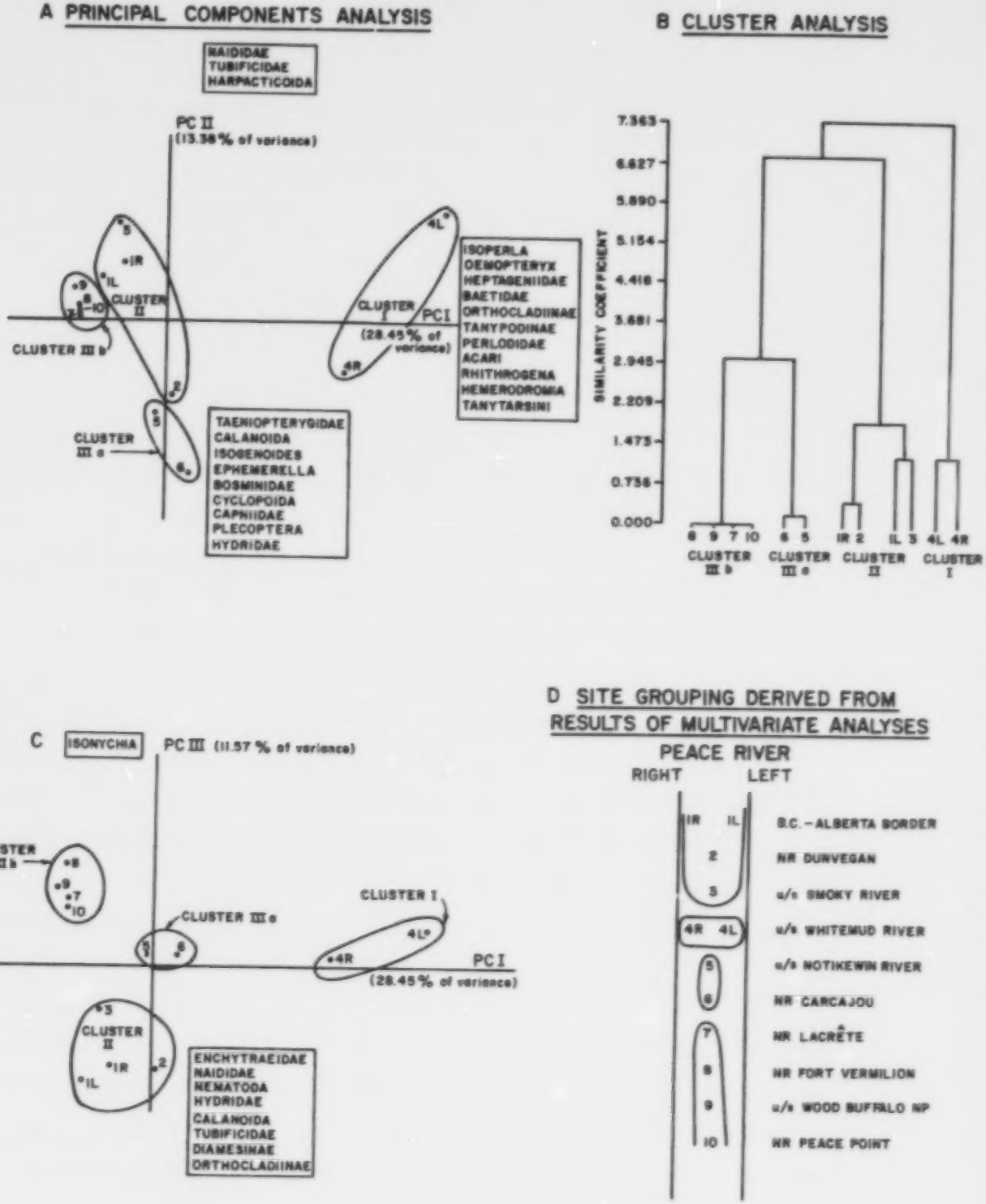

Fig. 65. Multivariate analyses of zoobenthic data from the Peace River, September - October 1988.

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4.6 MIXING BETWEEN SMOKY AND PEACE RIVERS

Water quality in the reach of the Peace River mainstem between the Smoky and Notikewin rivers is of concern because of the development of the Daishowa kraft pulp mill, downstream of the Town of Peace River. Additional samples were collected in this reach as part of the synoptic surveys in May and October 1988 and February 1989 (Fig. 3; Appendix XI). These data provide a baseline to evaluate the future impact of effluent from the pulp mill on mainstem water quality, and they are used here to assess the existing mixing regime of the Smoky River with the Peace River.

An ideal water quality constituent for assessing mixing patterns between the Smoky and Peace rivers is one that:

- is present in high concentrations in the Smoky River relative to upstream concentrations in the Peace River,
- is conservative so that processes such as adsorption, sedimentation, and biotransformation do not affect concentrations, and
- does not enter the study reach in appreciable concentrations from other sources so as to complicate the mixing pattern.

Of the constituents analyzed in the Smoky-Notikewin reach, sulphate most closely satisfied the above criteria, particularly for the October 1988 and February-March 1989 surveys. In May 1988, sulphate concentrations in the Smoky River were low and in the mainstem high, so the mixing pattern could not be assessed (Appendix XI).

During both the October and February-March surveys, sulphate concentration in the Peace River mainstem increased sharply at the first site downstream of the confluence with the Smoky River (Table 13). At that site, 30 km downstream of the confluence, sulphate concentrations were highest near the right bank and decreased towards the left bank. The elevated sulphate concentrations downstream of the Smoky River, the peak concentrations along the right bank (where the Smoky River enters

Table 13. Sulphate concentrations in the Peace River mainstem and the Smoky River.

Site	River km	Sulphate Concentration (mg/L) L	LC	C	RC	R
October 1988						
u/s Smoky River	213			7.8		
Smoky River	223			36.4		
d/s Daishowa	253	8.7	9.2	11.7	18.0	21.7
u/s Whitemud R.	286	9.7	11.1	12.9	14.1	14.6
east of Manning	327	11.7	12.1	12.1	12.6	13.2
Feb.-March 1989						
u/s Smoky River	213			8.6		
Smoky River	223			100		
d/s Daishowa	253	8.6	8.6	10.6	16.3	17.5
u/s Whitemud R.	286	9.2	9.9	10.9	11.3	12.0
east of Manning	327	9.3	9.2	9.6	10.4	11.2

L - left bank, LC - left centre, C - centre, RC -right centre, R - right bank.

the Peace River,, and the lack of other major sources of sulphate indicate that loading from the Smoky River was the source of the elevated sulphate concentrations in the mainstem. At the site 30 km downstream of the Smoky River, the plume was contained primarily within the right half of the mainstem channel. Some mixing across the entire channel was apparent at a site 63 km downstream of the confluence with the Smoky River, although a concentration gradient from right to left bank existed. At the final reach site, 104 km downstream of the confluence with the Smoky River, further transverse mixing had occurred; however, elevated concentrations were still apparent along the right bank. Thus, during the October and February-March synoptic surveys, the mixing zone for the Smoky River was in excess of 104 km. Further data collection would be required to elucidate the full extent of the Smoky River plume.

4.7 SURFACE WATER QUALITY CHARACTERIZATION

Multivariate analysis techniques were used to group together sampling sites from the Peace River Basin that were of similar water quality characteristics. Mainstem and tributary data collected from three of the synoptic surveys were evaluated: ice-covered, low flow conditions in February-March 1989, open-water peak flows in June 1988, and open-water low flows in October 1988. A subset of 11 water quality variables were evaluated (Table 14). Major ions and TDS were excluded because they were highly correlated to specific conductance. Total phosphorus, total nitrogen, particulate organic carbon and total metals were excluded because they were all highly correlated to suspended solids. In addition, constituents consisting of a large number of censored data or those with little variation in concentrations between surface waters in the Peace River Basin were excluded.

Results of the multivariate analyses are summarized in Figures 66 to 71. Each figure includes a dendogram that presents the results of

Table 14. Variables included in multivariate analysis of surface water quality, and legend of site codes for figures 66 to 71.

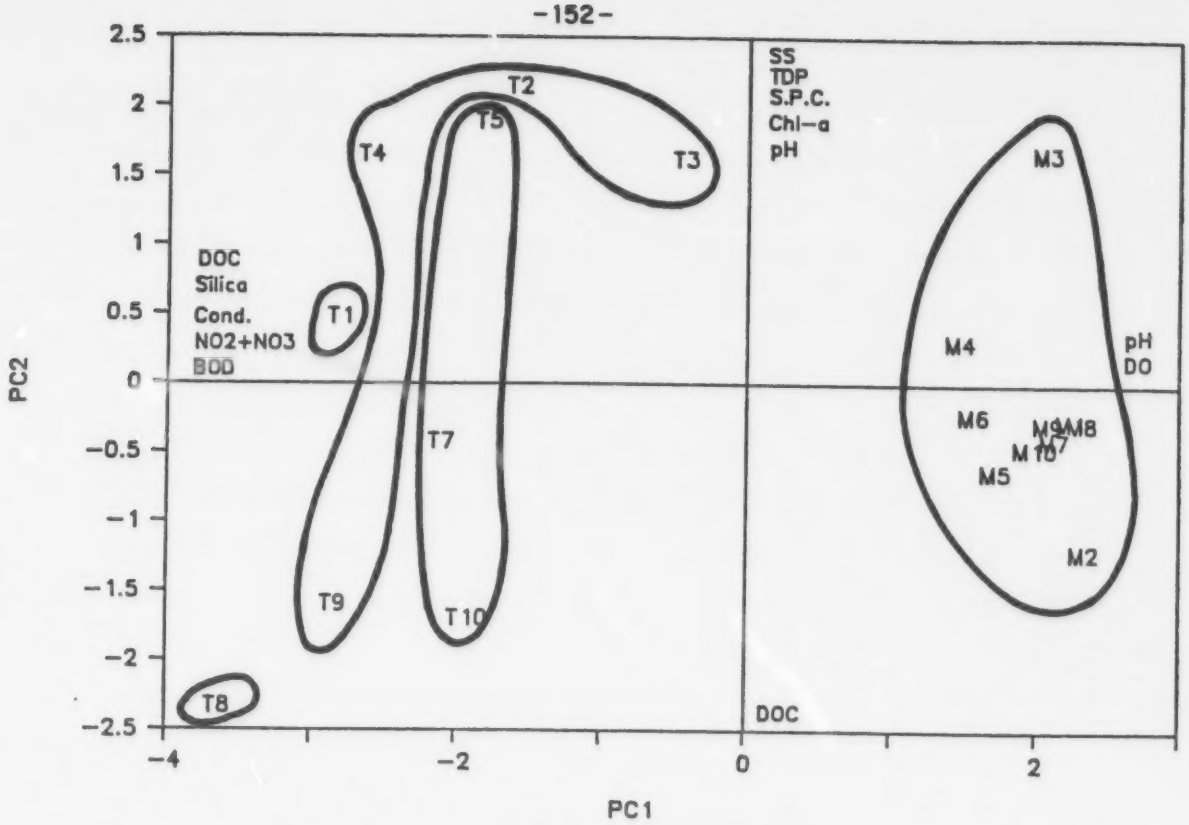
Variable	Transformation
pH	-
Specific Conductance	-
Silica	-
Dissolved Oxygen	-
Biochemical Oxygen Demand	log
Suspended Solids	log
Dissolved Organic Carbon	-
Dissolved Phosphorus	-
NO_2+NO_3-N	-
Planktonic Chlorophyll-a	log
Standard Plate Count (bacteria)	log

Site	Code
Mainstem	
B.C./Alberta border	M1
Dunvegan	M2
u/s Smoky River	M3
u/s Whitemud River	M4
u/s Notikewin	M5
near Carcajou	M6
near La Crete	M7
near Ft. Vermilion	M8
u/s Wood Buffalo National Park	M9
near Peace Point	M10
Tributaries	
Pouce Coupe River	T1
Smoky River	T2
Whitemud River	T3
Cadotte River	T4
Notikewin River	T5
Wolverine River	T6
Keg River	T7
Boyer River	T8
Wabasca River	T9
Wentzel River	T10

the cluster analysis and a scatter plot of the first two principal components (PC1 and PC2) derived from principal component analysis (PCA). Cluster analysis groups sites with similar water quality characteristics. The scale in the dendogram is a measure of decreasing similarity. PCA involves transforming a set of variables (e.g, water quality constituents) to a new set of variables (principal components) that account for the largest possible amount of variation in the data (Green 1979). The major cluster groups are outlined in PC scatter plots. The first two principal components explained from 54 to 82 % of the variance in the data set, and the important (negative and positive) constituents for PC1 and PC2 are indicated on the plots. The site codes shown on the figures are as outlined in Table 14.

Cluster analysis of the entire data set tended to separate the mainstem sites from the tributaries, and the tributaries clustered into one to four major groups. The groupings were most distinct in the winter survey (Fig. 66), likely as a result of the greater importance of groundwater seepage to the tributaries during that time of the year. Mainstem sites grouped high on PC1 and were characterized by high values of pH and DO and low values of DOC, silica, $(NO_2^- + NO_3^-)$-N, BOD, and conductivity. The tributaries clustered into four groups - the Pouce Coupe River and Wabasca River in separate groups, the Notikewin, Keg and Wentzel into one group, and the remaining tributaries into another group. The Pouce Coupe and Wabasca rivers were characterized by high values of conductivity and silica and low pH, and the Wabasca River was set apart by its high DOC content. Water quality of the other groups was more variable, although values of most constituents, with the exception of pH and DO, were higher than the mainstem group and lower than in the Pouce Coupe or Wabasca River.

During peak, open-water flows the mainstem sites clustered together with the Smoky, Boyer, and Wentzel rivers (Fig. 67). With the exception of the Boyer River, this group was characterized by relatively



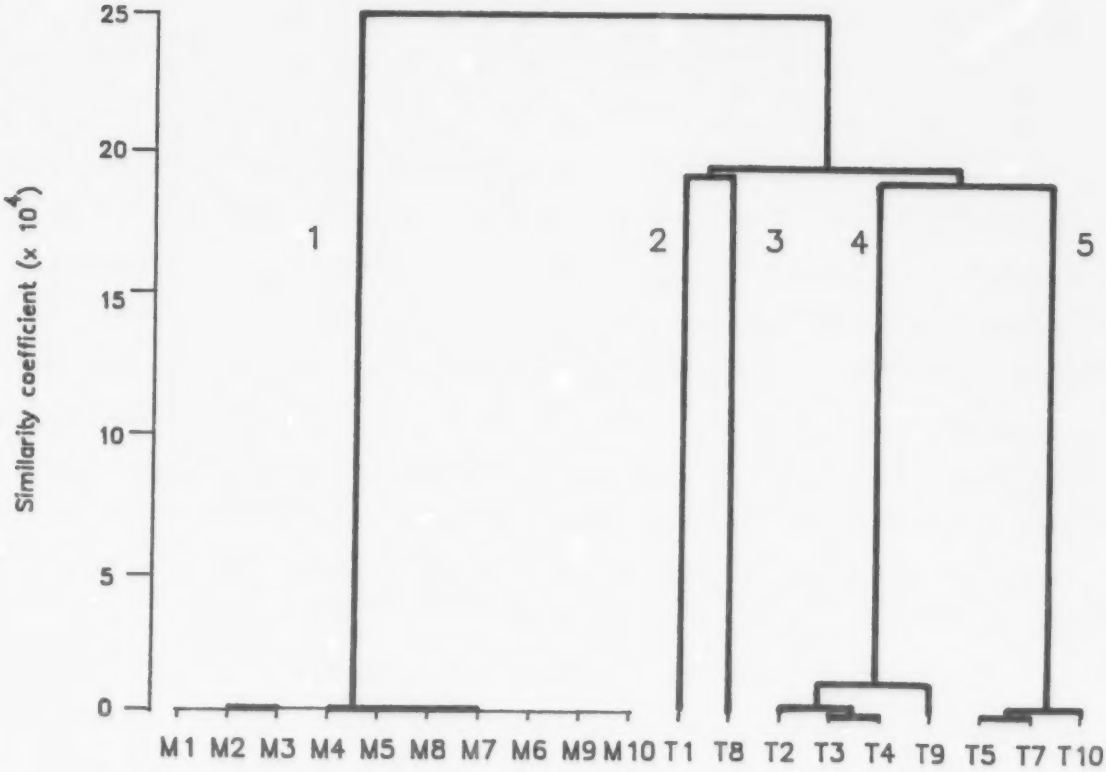


Fig. 66. Multivariate analysis of surface waters, Feb. – March 1989.

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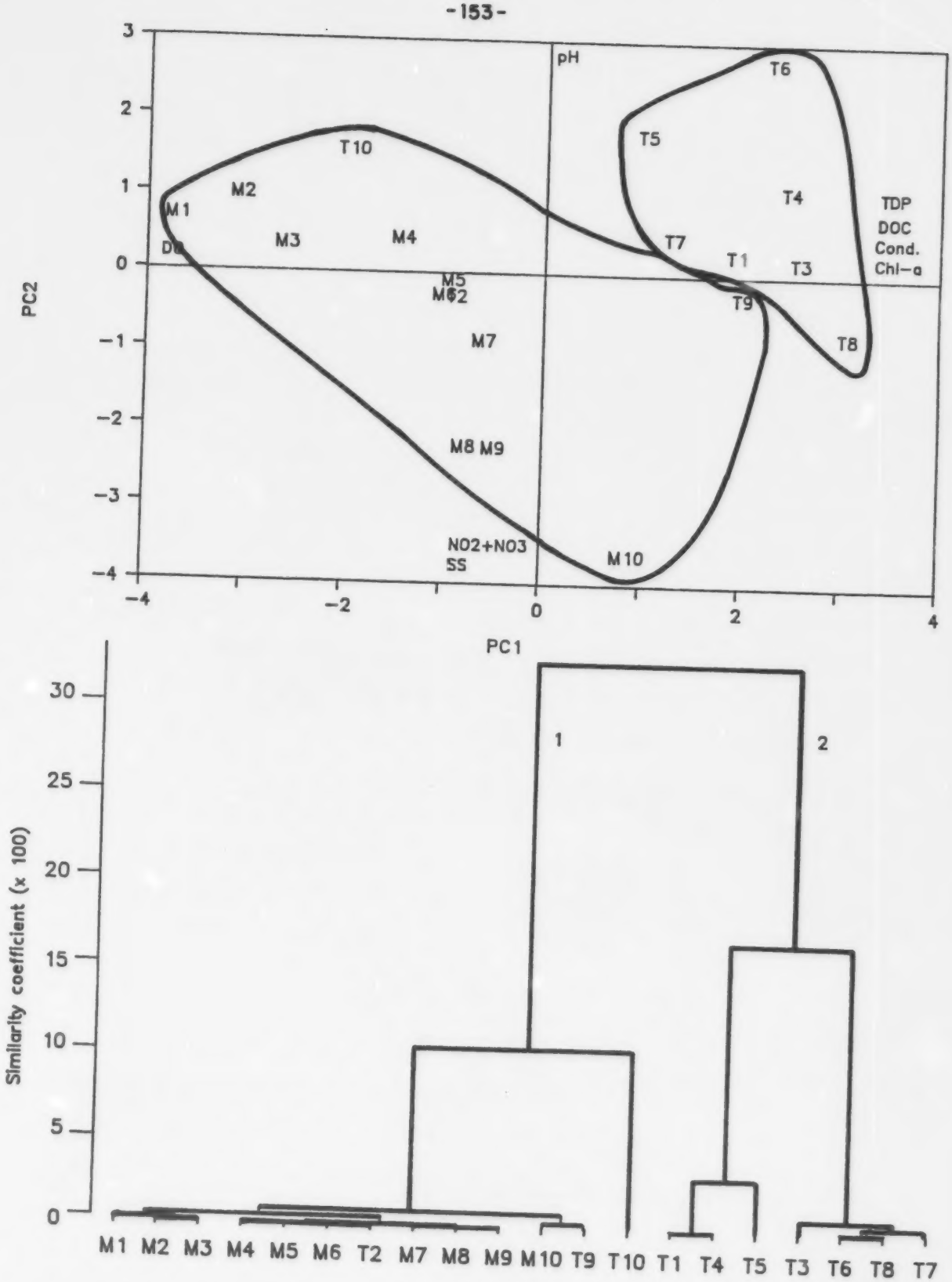

Fig. 67. Multivariate analysis of surface waters, June 1988.

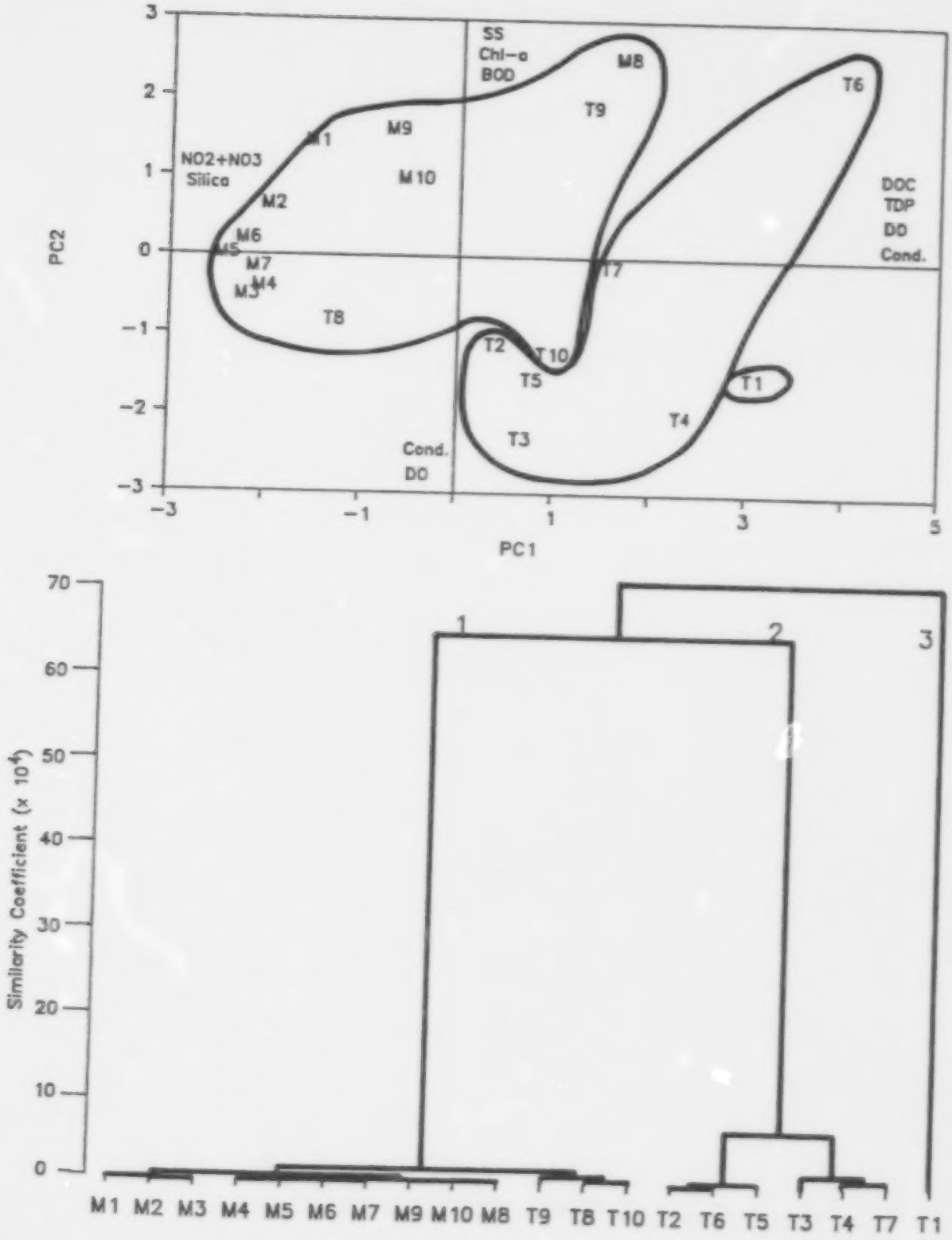

Fig. 68. Multivariate analysis of surface waters, October 1988.

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high concentrations of DO and low values of TDP, DOC, chlorophyll-a, and conductivity. The remaining tributaries generally clustered high on PC1 and PC2 and were characterized by high values of TDP, DOC, conductivity, chlorophyll-a, and pH.

The October data clustered into three major groups (Fig. 68). One group consisted of the mainstem sites and the three northern-most tributaries - the Boyer, Wabasca, and Wentzel rivers. That group was characterized by high concentrations of $(NO_2^- + NO_3^-)$-N and silica and low values of DOC, TDP, and conductivity. A second cluster consisted of the remaining tributaries with the exception of the Pouce Coupe River. The Pouce Coupe River was set apart from the other groups by its high conductivity. The water quality of the other tributary group was intermediate between the mainstem group and the Pouce Coupe River.

In summary, the mainstem sites were separated from most tributaries and were characterized by high DO and low values for most other variables. The distinct separation of the mainstem and most of its tributaries likely reflects the Cordilleran origin of the Peace River and the influence of the Bennett Dam, which reduces seasonal variability in flow and water quality. The Pouce Coupe River was the most distinct tributary; it clustered separately from most other tributaries except during high flow conditions. The separation of the Pouce Coupe River may reflect the high proportion of agricultural land in its drainage basin and also the input of municipal sewage from the Town of Dawson Creek.

Additional multivariate analyses were carried out with data collected from the mainstem sites only to differentiate water quality reaches along the mainstem. For all three surveys, the three sites from the B.C.-Alberta border to upstream of the confluence with the Smoky River clustered into a distinct group (Fig. 69 to 71). The remaining sites clustered into one to three major groups.

In winter, the upstream group was characterized by relatively high

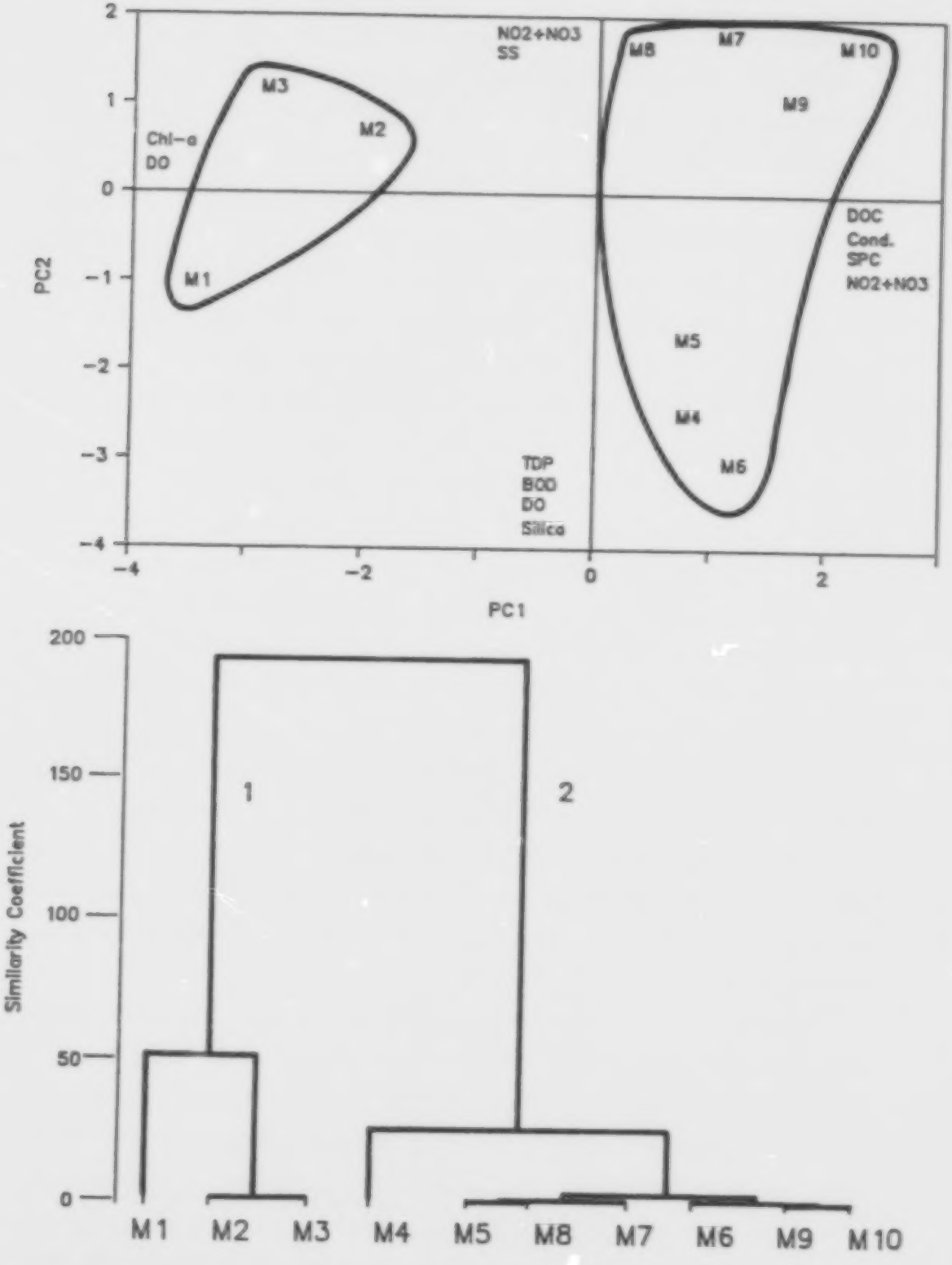

Fig. 69. Multivariate analysis of mainstem sites, Feb. – March 1989.

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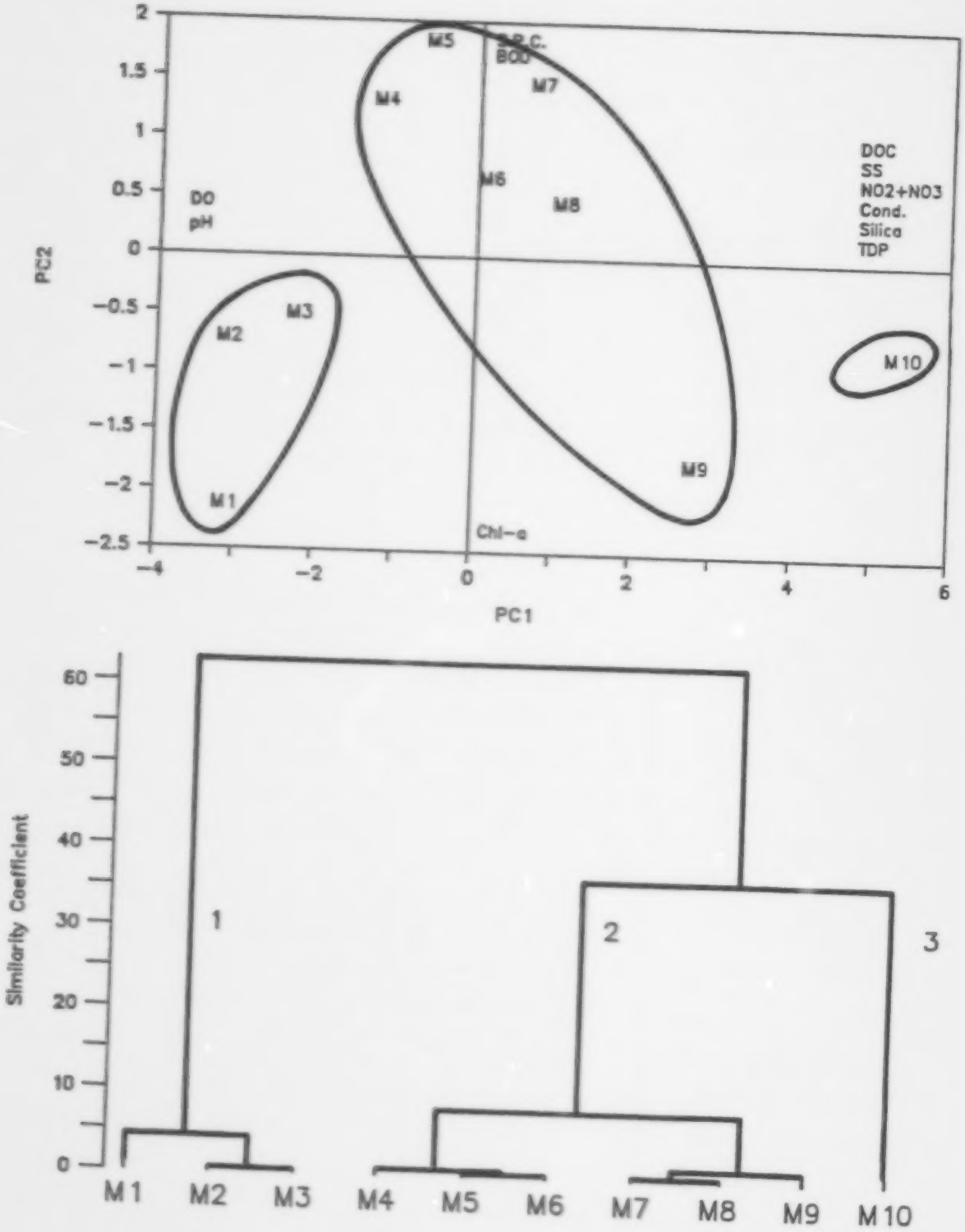

Fig. 70. Multivariate analysis of mainstem sites, June 1988.

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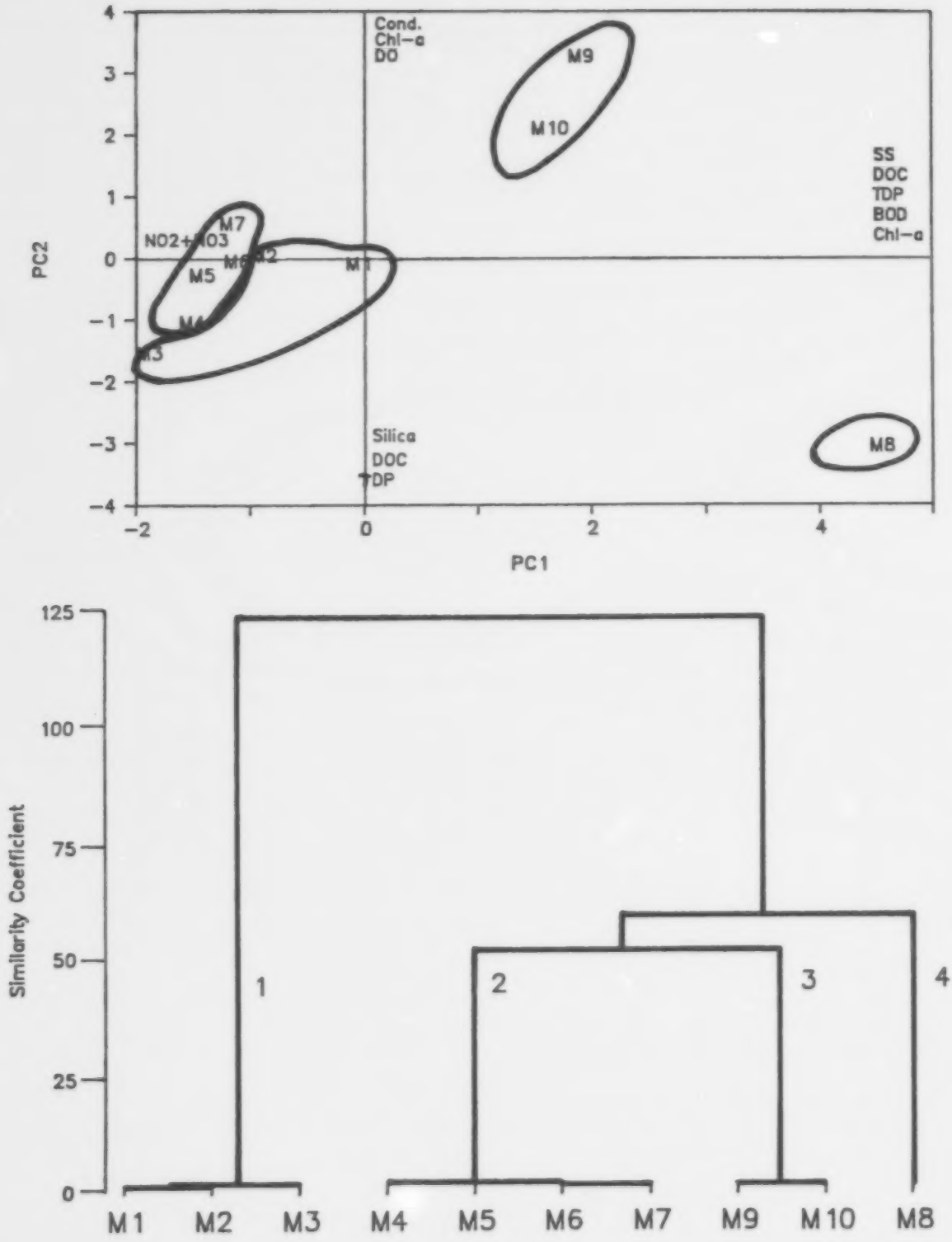

Fig. 71. Multivariate analysis of mainstem sites, October 1988.

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concentrations of chlorophyll-a and DO and low values of DOC, conductivity, and heterotrophic bacteria (Fig. 69). The remaining mainstem sites grouped high on PC1 and were characterized by higher values of DOC, conductivity, standard plate count, and $(NO_2^- + NO_3^-)$-N.

During peak flows in June, the upstream group was characterized by high DO and low DOC, suspended solids, conductivity, silica, and TDP (Fig. 70). Sites from upstream of the Whitemud River to Wood Buffalo National Park grouped together; those sites tended to group high on PC2 and were characterized by high values of suspended solids, DOC, TDP, $(NO_2^- + NO_3^-)$-N, and chlorophyll-a. The site farthest downstream at Peace Point grouped separately, reflecting higher concentrations of suspended solids, DOC, TDP, $(NO_2^- + NO_3^-)$-N, and chlorophyll-a.

Four major groups were apparent during the low-flow, open-water conditions in October (Fig. 71). The upstream group was set apart by low conductivity and high silica values. Sites from Fort Vermilion to Peace Point grouped high on PC1. The Ft. Vermilion site was separated because of an exceptionally high suspended solid concentration. The group of sites from upstream of the Whitemud River to LaCrete was not obviously different from the upstream group on a plot of PC2 on PC1. However, investigation of a plot of PC3 on PC1 (not shown) indicated a more distinct separation of the two groups on the basis of relatively high values of pH and conductivity in the Whitemud to LaCrete group.

In summary, the seasonal multivariate analysis of the mainstem water quality revealed a distinct separation of the reach from the B.C.-Alberta border to upstream of the confluence with the Smoky River. That reach was characterized by high concentrations of DO and lower concentrations of most other variables; there is little impact from tributaries or effluents on the water quality of the upstream reach. Downstream of the Smoky River, there was less distinct separation of reaches. However, sites from Ft. Vermilion to Peace Point tended to separate from the others. This downstream reach was set apart by lower

concentrations of DO and higher concentrations of most other variables, especially suspended solids. The high concentrations reflect the cumulative influence of downstream tributary and effluent loadings and the change in the composition of channel bed and banks that affects concentrations of suspended solids and associated variables. In general, water quality of the remaining mainstem sites (reach from upstream of the Whitemud River to LaCrete) was intermediate between the upstream and downstream reaches and could be viewed as a transition zone, reflecting the progressive change in mainstem water quality as a result of changes in channel geomorphology and the cumulative loadings from effluents and tributaries. Three similar water quality reaches have been reported for the Athabasca River (Hamilton et al. 1985). However, in the Athabasca River the differences between the reaches were more pronounced. This is likely due to the greater importance of tributary input to the middle reach of the Athabasca River compared to the Peace River.

5. GENERAL DISCUSSION

The Peace River drains much of northern Alberta. In general, the water quality of the river changes as it flows across the province, largely as a result of natural factors rather than anthropogenic impacts. Three water quality reaches were identified within Alberta - an upstream reach, an intermediate reach, and a downstream reach.

The upstream reach extends from the B.C.-Alberta border to the confluence with the Smoky River. Water quality of this reach is defined by the mainstem water quality as it crosses the border plus tributary loads and diffuse runoff to the Peace River in Alberta. There are no anthropogenic point-source effluents that discharge directly to this reach, although municipal effluent from Dawson Creek, B.C. discharges to a tributary of the Pouce Coupe River, which in turn discharges to the mainstem in Alberta. The municipal effluent adversely affects the water quality of the Pouce Coupe River (Butcher 1985), however, no effects on the water quality of the Peace River were observed during the 1988-89 synoptic surveys. The upstream reach is characterized by relatively low values for colour, turbidity and suspended solids (except during high flows), TDS, major ions, BOD, metals, nutrients, organic carbon and bacteria and by relatively high values of DO, oil and grease, and chlorophyll-a (planktonic and epilithic). The low concentrations for most variables were likely a result of the Cordilleran origin of the Peace River. The high chlorophyll-a values were likely a result of the low turbidity, which would allow greater light penetration and algal growth. Outflow of phytoplankton from Williston Reservoir may also contribute to the high chlorophyll-a values. The high oil and grease concentrations were probably a result of natural processes. The trace organic compounds that were tentatively identified in this reach may have originated from point-source effluents and/or diffuse anthropogenic inputs. Diffuse runoff from agricultural land in B.C. and Alberta, as

well as atmospheric deposition, were the likely sources of the pesticides detected in the Peace River at Dunvegan.

The intermediate reach extends from downstream of the confluence with the Smoky River to upstream of Ft. Vermilion. Water quality in this reach is intermediate between the upstream and downstream reaches and is influenced by upstream loads, tributary loads, diffuse surface runoff from agricultural land, groundwater inflow, and effluent discharge. The Smoky River is the largest tributary to the Peace River in Alberta and is the single largest point-source load for most constituents. Even so, in 1988-89, no dramatic increases in constituent concentrations were observed in the Peace River downstream of the confluence with the Smoky River, because for most constituents, concentrations in the Smoky were similar to or only slightly greater than in the mainstem. However, for some constituents (major ions, inorganic nitrogen, phosphorus, phenolics, tannin and lignin, and heterotrophic bacteria) concentrations in the Smoky River were considerably higher than in the Peace River and elevated levels of these compounds would be expected in the Smoky River plume (which was not sampled).

Concentrations of most constituents increased gradually along the intermediate reach of the river. The increase was largely a result of the cumulative loads from the tributaries and perhaps groundwater discharge from buried channel gravels. The headwaters of most tributaries to the Peace River in Alberta originate in the sedimentary basin. Consequently, concentrations of most constituents are higher in the tributaries than in the Peace or Smoky rivers, both of which originate in the Cordillera. Increases in sodium and chloride were partly a result of effluent discharge from Procter and Gamble's pulp mill (via the Smoky River) and the abandoned Peace River Oils #1 flowing well. In addition, high coliform levels downstream of the Town of Peace River may have been due to discharge of its municipal wastewater.

Elevated heterotrophic bacteria counts downstream of the Smoky River may have been due to effluent discharge from Procter and Gamble's pulp mill. Sample contamination and/or runoff from agricultural land may have been the source of trace organics detected in this reach.

The downstream reach extends from Ft. Vermilion to Peace Point. The water quality of this reach is influenced by upstream loads, tributaries, and changes in river geomorphology. The effect of the single effluent (Ft. Vermilion sewage) that discharges in this reach is negligible. The most conspicuous feature of the reach is the high concentrations of suspended solids and associated variables such as turbidity, BOD, total metals, and nutrients. The high turbidity likely inhibits the growth of phytoplankton, and as a result planktonic chlorophyll-a concentrations were low. The high values for suspended solids and associated variables were primarily a result of changes in channel bed and bank materials from gravel to sand and silt. Concentrations of most of the dissolved constituents (e.g., TDS, major ions, dissolved metals) were also highest in this reach of the river. The Wabasca River is the major tributary in this reach and is the second largest tributary of the Peace River in Alberta. For most constituents, the Wabasca River is the second largest point-source load to the Peace River. However, because of the high background concentrations in the Peace River, no increases in constituent concentrations were observed in the mainstem in 1988-89 as a result of loading from the Wabasca River. An interesting feature of the tributaries in this reach is the predominance of brownwater streams, as a result of drainage from peatlands. Consequently, tributaries within this reach tend to be highly coloured, with high concentrations of DOC and iron.

There was a considerable degree of similarity between the site classification based on invertebrate data and that based on water chemistry data. This suggests that water chemistry influences

zoobenthic community composition, or, more likely that both water quality and zoobenthos are influenced by common factors. Among these factors, geomorphic, physiographic, and hydrologic characteristics are likely to have a decisive influence. Schaeffer and Perry (1986) consider that zoobenthic communities are distributed along abiotic gradients. In the Peace River, gradients are apparent in water chemistry, substrate type, river discharge, current velocity, and the gradient (slope) of the riverbed. All of these factors are known to influence zoobenthic distribution directly, or indirectly (e.g., Cushing et al. 1983, Wright et al. 1984, Statzner and Higler 1986, Omerod and Edwards 1987, Corkum 1989).

Substrate type is a function of flow velocity, river slope and geology, and substrate is one of the habitat characteristics that showed considerable longitudinal changes among benthic invertebrate sampling sites. Therefore, it is of interest to examine the relationship between substrate and benthic invertebrate community composition. The substrate at sites along the upstream reach (i.e., B.C.-Alberta border to Smoky River) consists primarily of loose cobble with some pebble and sand. This substrate is heterogeneous and offers spatial refugia to a variety of invertebrates (e.g., those which live attached to rocks, under rocks, or in the interstitial silt and sand). The abundance of spatial refugia may not be the only reason for the presence of a diverse and abundant invertebrate community in this reach. In addition, the amount of detritus that may become trapped could contribute to spatial preference because detritus is a major source of food for many invertebrates (Flecker and Allan 1984). The presence of epilithic algae, which was most abundant in this reach, also contributes to the invertebrate food base.

In contrast to the mixed cobble substrate of the upper reach, the sandy substrate of the downstream reach (i.e., LaCrete to Peace Point) offers a less stable and less physically diverse habitat for benthic

invertebrates. Sand offers few spatial refugia and little opportunity for detritus to accumulate or primary producers to become abundant. As a result, fewer invertebrate species and lower numbers of invertebrates tend to colonize sandy substrates compared to gravel or stones (cobbles) (e.g., Doeg et al. 1989).

The substrate at Notikewin and Carcajou in the intermediate reach contains more sand and silt than sites from the upstream reach, but less than those from the downstream reach. The invertebrate association that inhabits this area tends to have transitional features as well. However, substrate characteristics alone do not explain the differential zoobenthic composition on the left and right banks of the Peace River, upstream of the Whitemud River. Incomplete lateral mixing of the Peace and Smoky rivers in this reach may influence the left-right bank differences.

In many respects, the water quality of the Peace River is unique compared to the other major rivers in Alberta. In the Peace River, concentrations of dissolved constituents tend to be lower and more constant (both seasonally and spatially - i.e., as it flows across the province) and concentrations of particulate matter tend to be higher, as compared to other Alberta rivers. In addition, the water quality of the Peace River is not markedly affected by point-source effluent discharges. The low concentrations and minimal seasonal and spatial variability for the dissolved constituents are a result of the Cordilleran origin of much of the water in the Peace River, its large size relative to discharges from effluents and tributaries, and the release of water of a relatively constant quality from Williston Reservoir. The high concentrations of particulate matter are a result of the high flows and geomorphic conditions in the Peace River mainstem and its tributaries.

Compared to the Peace River, the water quality of the Athabasca

River (a large, unregulated, northern river) exhibits greater seasonal and longitudinal variation as a result of inputs from relatively large tributaries and pulp mill effluents (Hamilton et al. 1985; Noton and Shaw 1989). The regulated North Saskatchewan River, which flows through central Alberta, is markedly affected by municipal wastewaters from the City of Edmonton, particularly with respect to dissolved oxygen, nutrients, organic compounds, and bacteria (Mitchell et al. 1986). In winter, the Peace River remains nearly saturated with dissolved oxygen; in contrast, the Athabasca and North Saskatchewan rivers exhibit a DO saturation deficit of up to 50 % in their middle or lower reaches.

In the southern rivers, such as the Bow and Oldman, nutrient input from municipalities, high water temperatures, and low turbidity results in a more prolific growth of aquatic biota compared to that in the Peace River (Cross et al. 1986). Concentrations of dissolved constituents are also higher in these southern rivers as a result of the drier climate and influence of irrigation.

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Appendix. I. Historical sampling sites on the Peace River mainstem and its tributaries in Alberta.

NAQUADAT Code	Location	Maximum Number of Samples	Period of Record
00AL07FD0003*	Ksituan River west of Spirit River	7	1971-1974
00AL07FD0002*	Peace River at Hwy 2, near Dunvegan	127	1969-1988
00AL07FD0005*	Hines Creek near Fairview	4	1971-1973
00AL07FD0004*	Clear River near Canyon	4	1971-1974
00AL07FD0006*	Montagneuse River near Hines Creek	5	1971-1974
00BC07FD1000	Peace R. near B.C.-Alberta border-left	4	1987-1988
00BC07FD1050	Peace R. near B.C.-Alberta border-centre	4	1987-1988
00BC07FD1100	Peace R. near B.C.-Alberta border-right	4	1987-1988
00AT07FD2030	Peace River at Dunvegan	43	1970-1978
00AL07FD5000	Peace River u/s Smoky River	4	1983
00AL07GJ0001*	Smoky River at Watino	216	1967-1989
00AL07GJ4995	Smoky River at mouth - left bank	4	1983
00AL07GJ5000	Smoky River at mouth - right bank	4	1983
00AL07GJ5005	Smoky River at mouth - centre	2	1983
00AL07HA0001*	Peace River at Peace River	140	1960-1974
00AL07HA0007*	Heart River near Nampa	9	1971-1973
00AL07HA0008*	Whitemud R. near Dixonville	9	1969-1974
00AL07HA2035	Peace R., u/s Heart R.-left of centre	2	1983
00AL07HA2038	Peace R., u/s Heart R.-right of centre	2	1983
00AL07HA2040	Peace R., u/s Heart R.-left	21	1970-1983
00AL07HA2041	Peace R., u/s Heart R.-right	21	1970-1983
00AL07HA2050	Peace R. d/s Town of Peace River	1	1970
00AL07HB0001*	Cadotte River near mouth	2	1969-1971
00AL07HC0006	Notikewin River at Manning	9	1969-1974
00AL07HE0001*	Wolverine River near mouth	1	1969
00AL07HF0001*	Peace River at Fort Vermilion	55	1967-1974
00AL07HF0002*	Keg River at Keg River Cabins	9	1969-1977
00AL07HF1000	Keg River at Hwy. 35	1	1987
00AL07JD0001*	Wabasca River at Wadlin Lake Road	70	1969-1977
00AL07JF0002*	Boyer River at Hwy. 58A	1	1969
00AL07JF0003*	Caribou River east of Rocky Lane	8	1969-1974
00AL07JF1000	Boyer River at Hwy. 67	1	1987
00AL07KC0001*	Peace River at Peace Point	81	1967-1977

* Federal and/or B.C. sites. Smoky River at Watino is now operated by Alberta Environment.

For tributaries, only sites at or near mouths are included.

Appendix II. Water quality variables and analytical methods for 1988-1989 surveys.

Parameter	Container	Preservation	Analytical Code	Analytical Method or Instrument
Field Analysis				
Temperature			02061F	Field meter
pH			10301F	Field meter
Conductance			02041F	Field meter
Oxygen, dissolved			08102F	Field meter
Lab Analysis				
pH	P	Cool to 4°C	10301L	Meter
Ca	P	Cool to 4°C	20103L	Automated atomic absorption
Mg	P	Cool to 4°C	12102L	Atomic absorption, direct aspiration
Na	P	Cool to 4°C	11103L	Flame photometry
K	P	Cool to 4°C	19103L	Flame photometry, internal standard
HCO_3			06202L	Calculated
CO_3			06302L	Calculated
Cl	P	Cool to 4°C	17203L	Colourimetry on autoanalyzer
SO_4	P	Cool to 4°C	16305L	Colourimetry, $BaCl_2$ and methylthymol blue
Silica, reactive	P	Cool to 4°C	14105L	Heteropoly blue colourimetry
F, dissolved	P	Cool to 4°C	09107L	Automated potentiometric method
Conductance	P	Cool to 4°C	02041L	Meter
Turbidity	P	Cool to 4°C	02074L	Nephelometric method with turbidimeter
Total dissolved solids			00201L	Calculated
Hardness, total	P	Cool to 4°C	10604L	Titration with EDTA
Alkalinity, total	P	Cool to 4°C	10101L	Potentiometric titration
Alkalinity, phenol phth.	P	Cool to 4°C	10151L	Potentiometric titration
Filterable residue	P	Cool to 4°C	10451L	Gravimetric method
Suspended Solids	P	Cool to 4°C	10407L	Gravimetric method
NO_2+NO_3-N	P	Cool to 4°C	07110L	Colourimetry on autoanalyzer
Ammonia-N	P	2ml 5% H_2SO_4	07505L	Colourimetric analysis
Total Kjeldahl Nitrogen	P	2ml 5% H_2SO_4	07015L	Colourimetry on autoanalyzer
Nitrogen, total	P		07602L	Calculated
Phosphorous, total	P	2ml 5% H_2SO_4	15406L	Colourimetry on autoanalyzer
Phosphorous, dissolved	P	2ml 5% H_2SO_4	15103L	Colourimetry on autoanalyzer
Biochemical oxygen demand	G	Cool to 4°C	08202L	5 day, 20°C
C, dissolved organic	P	Cool to 4°C	06104L	Colourimetry
C, total organic	P	Cool to 4°C	06005L	Thermal conductivity
Phenols	G	1:1 H_2SO_4	06537L	Automated 4-aminoantipyrine colourimetry
Tannin and Lignin	G	Cool to 4°C	06551L	Filtered if turbid: acid colourimetry
Colour, true	G	Cool to 4°C	02021L	Visual comparison with std. colour soln's.
Oil and Grease	G	1:1 H_2SO_4	06524L	Petroleum ether extraction
CN	P	6N NaOH	06608L	Colourimetry on autoanalyzer
Al, total	P	1:1 HNO_3	13303L	Atomic absorption, solvent extraction
As, total	P	1:1 HNO_3	33005L	Goulden and Brooksbank's method
Ba, total	P	1:1 HNO_3	56001L	Atomic absorption, direct apiration
Be, total	P	1:1 HNO_3	04002L	Atomic absorption, solvent extraction
Bo, total	P	1:1 HNO_3	05003L	ICAP method
Cd, total	P	1:1 HNO_3	48002L	Atomic absorption, solvent extraction
Cr, total	P	1:1 HNO_3	24004L	Atomic absorption, graphite furnace
Co, total	P	1:1 HNO_3	27002L	Atomic absorption, solvent extraction
Cu, total	P	1:1 HNO_3	29005L	Atomic absorption, solvent extraction
Fe, total	P	Cool to 4°C	26004L	Atomic absorption, direct aspiration
Pb, total	P	1:1 HNO_3	82002L	Atomic absorption, solvent extraction

P - polyethylene; G - glass

Appendix II. Continued...

Parameter	Container	Preservation	Analytical Code	Analytical Method or Instrument
Mn, total	P	1:1 HNO_3	25004L	Atomic absorption, direct aspiration
Hg, total	P	HNO_3-$K_2Cr_2O_7$	80011L	Flameless atomic absorption
Mo, total	P	1:1 HNO_3	42006L	Atomic absorption, solvent extraction
Ni, total	P	1:1 HNO_3	28002L	Atomic absorption, solvent extraction
Se, total	P	1:1 HNO_3	34005L	Goulden and Brooksbank's method
Ag, total	P	1:1 HNO_3	47005L	Atomic absorption, graphite furnace
V, total	P	1:1 HNO_3	23002L	Atomic absorption, graphite furnace
Zn, total	P	1:1 HNO_3	30005L	Atomic absorption, solvent extraction
Al, dissolved	P	1:1 HNO_3	13106L	Atomic absorption, solvent extraction
As, dissolved	P	1:1 HNO_3	33104L	Goulden and Brooksbank's method
Ba, dissolved	P	1:1 HNO_3	56101L	Atomic absorption, direct apiration
Be, dissolved	P	1:1 HNO_3	04111L	ICAP method
Bo, dissolved	P	1:1 HNO_3	05107L	ICAP method
Cd, dissolved	P	1:1 HNO_3	48102L	Atomic absorption, solvent extraction
Cr, dissolved	P	1:1 HNO_3	24052L	Atomic absorption, graphite furnace
Co, dissolved	P	1:1 HNO_3	27102L	Atomic absorption, solvent extraction
Cu, dissolved	P	1:1 HNO_3	29105L	Atomic absorption, solvent extraction
Fe, dissolved	P	Cool to 4°C	26104L	Atomic absorption, direct aspiration
Pb, dissolved	P	1:1 HNO_3	82103L	Atomic absorption, solvent extraction
Mn, dissolved	P	1:1 HNO_3	25104L	Atomic absorption, direct aspiration
Mo, dissolved	P	1:1 HNO_3	42102L	Atomic absorption, solvent extraction
Ni, dissolved	P	1:1 HNO_3	28102L	Atomic absorption, solvent extraction
Se, dissolved	P	1:1 HNO_3	34102L	Goulden and Brooksbank (1974)
Ag, dissolved	P	1:1 HNO_3	47102L	Atomic absorption, graphite furnace
V, dissolved	P	1:1 HNO_3	23102L	Atomic absorption, graphite furnace
Zn, dissolved	P	1:1 HNO_3	30105L	Atomic absorption, solvent extraction
Biological				
Total coliforms	G	Cool to 4°C	36001L	Tube dilution
Fecal coliforms	G	Cool to 4°C	36011L	Tube dilution
Standard plate count	G	Cool to 4°C	36905L	Agar plate at 35°C
Chlorophyll-a, planktonic	P	Cool to 4°C	06715L	Fluorometry of acetone extractant
Chlorophyll-a, epilithic	P	Cool to 4°C	06722L	Fluorometry of acetone extractant

P - polyethylene; G- Glass

Priority Pollutant Analysis Methodology

The method employed for extractable (semi-volatile) priority pollutants is based on the EPA Method 625 and covers the analysis of a number of organics that are partitioned into an organic solvent and are amenable to capillary gas chromatography/mass spectrometry (GC/MS). The method for purgeable (volatile) priority pollutants is based on EPA Method 624 and deals with organics that are purged from water onto a trap, then desorbed and analyzed by capillary GC/MS (Longbottom and Lichtenberg 1982).

Surface water is collected in the field directly into pre-treated one litre amber sample bottles and stored in a refrigerator at 2-50 degrees C until the time of analysis. The entire 1-L volume of sample is serially extracted with methylene chloride at a pH > 11 and again at a pH < 2 using a separatory funnel. The methylene chloride extracts are dried and concentrated, ready for GC/MS analysis.

Trace organic compounds analyzed in this study are listed on the following pages of this appendix, along with their detection limits (denoted U).

Appendix II. Continued...

ALBERTA ENVIRONMENTAL CENTRE
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ORGANICS ANALYSIS DATA SHEET

| SEMIVOLATILE COMPOUNDS |

| Sample Number |
| AEC:..... |
| User:..... |

File No : .....
QT FILE : .....
ANALYZED : .....
MM/DD/YY

User : .....
Group : .....
Date Sampled : .....
Time Sampled : ..... By: .....
Sample Locat : .....
User Comments: .....

AEC Proj #: .....
User Proj #: .....

Scan : .....
Matrix: .....
Human Consumption: .....
Dilution Factor: .....
Date Received: .....

NAQUADAT Number		ug/L	NAQUADAT Number		ug/L
95000	BENZOIC ACID	2.U	95028	PHENANTHRENE	1.U
95001	4-CHLORO-3-METHYLPHENOL	1.U	95029	PYRENE	1.U
95002	2-CHLOROPHENOL	2.U	95031	BENZO(b)FLUORANTHENE	1.U
95003	2,4-DICHLOROPHENOL	1.U	95032	2-CHLORONAPHTHALENE	1.U
95004	2,4-DIMETHYL PHENOL	2.U	95033	HEXACHLOROBENZENE	1.U
95005	2-METHYL-4,6-DINITROPHENOL	1.U	95034	HEXACHLOROBUTADIENE	5.U
95006	2,4-DINITROPHENOL	1.U	95035	HEXACHLOROCYCLOPENTADIENE	1.U
95007	HEXADECANOIC ACID	3.U	95036	HEXACHLOROETHANE	5.U
95008	2-NITROPHENOL	1.U	95037	1,2,4-TRICHLOROBENZENE	1.U
95009	4-NITROPHENOL	1.U	95030	ISOPHORONE	1.U
95010	PENTACHLOROPHENOL	1.U	95038	BENZIDINE	2.U
95011	PHENOL	1.U	95039	2,4-DINITROTOLUENE	1.U
95012	2,4,5-TRICHLOROPHENOL	1.U	95040	2,6-DINITROTOLUENE	1.U
95013	2,4,6-TRICHLOROPHENOL	1.U	95041	1,2-DIPHENYLHYDRAZINE	1.U
95014	ACENAPHTHENE	1.U	95042	NITROBENZENE	1.U
95015	ACENAPHTHYLENE	1.U	95043	N-NITROSODIPHENYLAMINE	1.U
95016	ANTHRACENE	1.U	95044	N-NITROSO-DI-n-PROPYLAMINE	2.U
95017	BENZO(a)ANTHRACENE	1.U	95045	4-BROMOPHENYL PHENYL ETHER	1.U
95018	BENZO(k)FLUORANTHENE	1.U	95046	BIS(2-CHLOROETHOXY)METHANE	1.U
95019	BENZO(ghi)PERYLENE	2.U	95047	BIS(2-CHLOROETHYL)ETHER	1.U
95020	BENZO(a)PYRENE	1.U	95048	BIS(2-CHLOROISOPROPYL)ETHER	1.U
95021	CHRYSENE	1.U	95049	4-CHLOROPHENYL PHENYL ETHER	1.U
95022	DIBENZO(ah)ANTHRACENE	5.U	95050	BUTYLBENZYLPHTHALATE	1.U
95023	FLUORANTHENE	1.U	95051	DIBUTYLPHTHALATE	1.U
95024	FLUORENE	1.U	95052	DIETHYLPHTHALATE	1.U
95025	INDENO(1,2,3-cd)PYRENE	1.U	95053	DIMETHYLPHTHALATE	1.U
95026	NAPHTHALENE	1.U	95054	DI-n-OCTYLPHTHALATE	1.U
95027	PERYLENE	1.U	95055	BIS(2-ETHYLHEXYL)PHTHALATE	1.U

CERTIFIED BY: R.D.SMILLIE

DATE: 1990_____

RESEARCH & METHODS DEVELOPMENT
CHEMISTRY DIVISION
ALBERTA ENVIRONMENTAL CENTRE

REPORT FILE,.....

Appendix II. Continued...

ALBERTA ENVIRONMENTAL CENTRE
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ORGANICS ANALYSIS DATA SHEET

| VOLATILE COMPOUNDS |

File No : .....
QT FILE : .....
ANALYZED : .....
MM/DD/YY

| Sample Number |
| AEC:..... |
| User:..... |

User : .....
Group : .....
Date Sampled : .....
Time Sampled : ..... By: .....
Sample Locat : .....
User Comments: .....

AEC Proj #: .....
User Proj #: .....

Scan : .....
Matrix: .....
Human Consumption: .....
Dilution Factor: .....
Date Received: .....

NAQUADAT Number		ug/L	NAQUADAT Number		ug/L
95200	BENZENE	1.U	95218	1,2-DICHLOROPROPANE	1.U
95201	BROMODICHLOROMETHANE	1.U	95219	cis-1,3-DICHLOROPROPYLENE	3.U
95202	BROMOFORM	5.U	95220	trans-1,3-DICHLOROPROPYLENE	3.U
95203	BROMOMETHANE	1.U	95221	ETHYLBENZENE	1.U
95204	CARBONTETRACHLORIDE	1.U	95222	METHYLENE CHLORIDE	20.B
95205	CHLOROBENZENE	1.U	95223	STYRENE	1.U
95206	CHLOROETHANE	1.U	95224	1,1,2,2-TETRACHLOROETHANE	1.U
95207	2-CHLOROETHOXYETHYLENE	4.U	95225	TETRACHLOROETHYLENE	3.U
95208	CHLOROFORM	1.U	95226	TOLUENE	1.U
95209	DIBROMOCHLOROMETHANE	1.U	95227	1,1,1-TRICHLOROETHANE	1.U
95211	1,2-DICHLOROBENZENE	1.U	95228	1,1,2-TRICHLOROETHANE	1.U
95212	1,3-DICHLOROBENZENE	1.U	95231	TRICHLOROETHYLENE	1.U
95213	1,4-DICHLOROBENZENE	1.U	95229	TRICHLOROFLUOROMETHANE	1.U
95214	1,1-DICHLOROETHANE	1.U	95232	VINYL CHLORIDE	30.U
95215	1,2-DICHLOROETHANE	1.U	95233	o-XYLENE	1.U
95216	1,1-DICHLOROETHYLENE	1.U	95234	m,p-XYLENE	1.U
95217	trans-1,2-DICHLOROETHYLENE	1.U			

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DATE: 1990_____

RESEARCH & METHODS DEVELOPMENT
CHEMISTRY DIVISION
ALBERTA ENVIRONMENTAL CENTRE

REPORT FILE,.....

Appendix III. General methods for the 1988-1989 synoptic surveys.

III.1. Field

In 1988-89, mainstem and tributary water samples were collected during the open-water season from either (1) the centre of the channel or (2) from the right and left banks and pooled into one composite sample (Appendix V). Access for much of the sampling was by helicopter. At the three mainstem sites where mixing between the Smoky and Peace rivers were assessed, grab samples were collected from a transect across the river (left bank, left centre, centre, right-centre, right bank). Tributaries were sampled near their confluence with the Peace River. Effluents were sampled as close to their point of discharge to the river as possible; grab samples were collected from the effluents. Discharge from some of the effluents was intermittent, and effluents were only sampled if they were discharging during the sampling trip.

During the ice-covered season, river samples were collected from holes drilled through the ice in the centre of the river channel, or for the reach samples, from five locations in a transect across the river.

Temperature, pH, oxygen, and conductivity were measured in situ with field meters. For the other parameters, water samples were collected in appropriate containers, fixed with preservatives (as required) and kept dark and cool until they were analyzed (Appendix II). A subset of parameters was analyzed for the Smoky-Notikewin reach samples (Appendix XI). Samples for analysis of planktonic chlorophyll-a and the dissolved fraction of phosphorus, nitrogen, and metals were filtered at the end of the day that they were collected. Samples normally reached the lab by the morning after they were collected.

Replicate and field blank samples were collected periodically for quality assurance. The replicates consisted of three serial grab samples collected a few minutes apart from one another at the same site. The blank samples contained distilled water from the analytical lab. The water was taken into the field and used to fill regular sample bottles under typical sampling conditions. The replicates and field blanks were submitted "blind" to the lab. These data are presented and discussed in Appendix IV.

Epilithic chlorophyll-a samples were obtained by sampling a 4 cm^2 area on each of five different rocks that were randomly selected from a depth of ~0.5 m. Triplicate samples were obtained at each site. Downstream of Ft. Vermilion, the river bottom was predominantly sand, and epilithic chlorophyll-a was not analyzed.

In selecting sampling sites for zoobenthos, attempts were made to standardize substrate, current velocity, and sampling depth, all of which are known to influence benthic invertebrate distribution. Samples were usually collected at a depth between 30 and 40 cm in moderately

fast flow.

Zoobenthos sampling was performed with a modified Neill cylinder sampler (Neill 1938) with a sampling area of 0.1 m^2 and a collecting net mesh aperture size of 0.210 mm. The upstream opening of the cylinder was fitted with a fine screen (mesh aperture 1 mm) to prevent inflow of drifting organisms. Five replicate samples were collected at each site. Care was taken to press the cylinder securely into the substrate to prevent the loss of specimens through gaps between the cylinder and the substrate. Larger stones were cleaned individually by gently rubbing and rinsing inside the cylinder. A narrow shovel was used to disturb the substrate for approximately one minute. Samples were preserved in 4 percent formaldehyde immediately after collection.

At each sampling site, sampling depth was measured with a metre stick to the nearest cm, and duplicate measurements of flow velocity were made with a Price meter type AA gauge. Rocks, sand, and silt were collected from a depth of 0 to 15 cm by pushing a 20-cm diameter PVC tube horizontally along the substrate. At least five samples were taken in the immediate vicinity of the sampling site and the samples were pooled. Rocks were measured or sieved following the Wentworth scale (Wentworth 1822 cited in Cummins 1962). Weights of individual size classes were expressed as a percentage of total sample weight.

Discharge of the Peace River and selected tributaries was measured by Technical Services Division of Alberta Environment or Water Survey of Canada. Where measurements were not available, discharge was estimated by the Hydrology Branch, Alberta Environment from analysis of nearby hydrometric stations. Discharge of most effluents was obtained from company or municipal records; discharge from the abandoned Peace River Oils flowing well was estimated visually.

III.2. LABORATORY

The analytical methods used for the 1988-89 synoptic surveys are outlined in Appendix II. Most water quality parameters were analyzed at Chemex Labs Alberta Ltd., Calgary. Chlorophyll-a samples were analyzed at the Millwoods facility of the EQMB, Edmonton. Bacteriological samples were analyzed by the Alberta Provincial Laboratory, Edmonton, and trace organic compounds were analyzed at the Alberta Environmental Centre, Vegreville.

Zoobenthic samples were stained with Rose Bengal upon return to the laboratory (Mason and Yevich 1967). Samples were sorted through two sieves with mesh apertures of 2 and 0.213 mm. Coarse fractions (residue on 2 mm screen) and fine fractions (residue on 0.213 mm screen) of each sample were sorted under a dissecting microscope (magnification range 6 to 50X). It was necessary to subsample the fine fraction of some samples that contained large numbers of organisms. Subsampling was performed using the Imhoff cone method described by Wrona et al. (1982). Specimens were counted and identified according to Baumann et al. (1977), Edmunds et al. (1976), Merritt and Cummins (1984), Pennak (1978), and Wiggins (1977).

Appendix IV. Quality assurance of 1988-1989 synoptic survey data.

IV.1. Data Verification

All 1988-89 synoptic survey data were inspected by the sampler and the project manager. Questionable values were checked with the lab and/or field personnel and were discarded if a reason for the aberration could be identified. After inspection and verification, lab data were transferred electronically to the NAQUADAT data base of EQMB. To avoid errors, data were downloaded electronically from NAQUADAT to an IBM-AT personal computer for manipulation and presentation in Apendices V and XI.

IV.2. Replicate Samples

On five occasions during the synoptic surveys, three grab samples were collected within a few minutes of one another at three sites on the Peace River mainstem. All replicates were submitted blind to the laboratory and analyzed for most variables except trace organics. These data are included in Appendix V, and the statistics describing their variability are summarized in Table IV.1. Duplicate samples for trace organic analysis were obtained on 23 August 1988 from the Ft. Vermilion site. The variability of serial grab samples provides an indication of the cumulative error that exists in a water quality measurement, that is, small-scale variations of constituent concentrations in time and space in the river, and sampling and laboratory analytical error.

For most constituents, variability as measured by the coefficient of variation (CV) was relatively low (<25 %), and in many cases, (e.g., major ions and related variables), CV was less than 5 %. On the other hand, variability was relatively high (>25 %) for suspended solids and many associated variables such as biochemical oxygen demand, bacteria, and total metals. The relatively high variability for these constituents probably reflects natural variability of particulate matter in the river water. The CV was also high for several dissolved constituents - phenolic compounds, ammonium, and some metals. The high variability for these dissolved constituents was probably due to their low concentrations in the river. At low concentrations, the analytical methods are less precise and, also, a small absolute difference in concentration would have a greater affect on the CV compared to solutes of higher concentration. Only two trace organic compounds were detected in water from Ft. Vermilion. Toluene was detected at trace concentrations in both samples and benzene was detected in trace concentrations in one of the replicates. The variability of replicate samples from the Peace River is consistent with that observed for recent work on the Athabasca River (Noton and Shaw 1989).

Table IV.1. Coefficient of variation (expressed as a percent) of replicate grab samples from the Peace River mainstem.

	u/s Smoky River		u/s Notikewin	Ft. Vermilion	
Variable	09/05/88	20/06/88	22/08/88	13/12/88	02/03/89
Ca	2.8	0.7	1.6	0.7	1.8
Mg	6.2	0.0	4.7	0.8	0.9
Na	2.4	0.0	4.2	1.4	2.4
K	2.7	1.6	5.6	2.3	1.3
Cl	7.4	4.3	0.0	2.0	2.8
SO_4	0.0	2.7	0.0	8.2	1.0
Tot. Alk.	1.3	0.7	1.9	0.5	0.5
pH	0.3	0.8	0.3	0.2	0.5
HCO_3	1.4	0.8	1.9	0.5	0.6
Tot. Hard.	0.4	0.5	2.1	0.6	1.1
F	9.1	17.3	21.7	0.0	55.1
Silica	4.9	4.7	2.0	0.6	0.8
Spec. Cond.	0.0	0.0	3.8	0.4	0.0
Tan. & Lig.		9.1	0.0	17.3	24.7
Turbidity	2.0	1.8	24.8	3.9	6.0
True Colour	0.0	17.3	24.7	21.7	34.6
BOD	55.1	83.9	52.7	33.3	31.5
Oil & Grease	0.0	33.3	0.0	0.0	21.7
Phenols	0.0	43.3	43.3	0.0	43.3
TOC	13.9	7.0	4.1	6.2	6.9
DOC	7.8	2.1	2.7	23.0	3.7
NH_3-N	17.3	34.6	43.3	0.0	0.0
TKN	14.4	7.9	28.9	32.8	20.0
NO_2+NO_3-N	5.6	17.4	0.0	6.8	2.8
TDP	7.9	0.0	9.1	25.0	0.0
TP	4.7	4.4	10.2	25.0	0.0
TFR	0.0	1.1	0.0	4.7	0.0
NFR	10.6	74.7	70.8	57.3	46.9
Chla	9.1	0.0	3.4	10.8	0.0
Tot. Col	0.0	7.5	48.7	62.5	26.6
Fecal Col.	0.0	73.0	65.5	32.9	68.0
Std. Pl. Coun	82.1	56.2	3.7	49.4	27.1
Al (Total)	35.6	18.1	0.0	15.7	34.6
As (Total)	6.2	13.7	15.7	10.8	26.6
Ba (Total)	4.7	0.0	0.0	0.0	13.3
Bo (Total)	48.6	99.0	57.7	0.0	8.7
Cr (Total)	100.7	39.7	0.0	0.0	43.3
Co (Total)	86.6	21.7	43.3	43.3	0.0
Cu (Total)	12.4	9.1	0.0	0.0	0.0
Fe (Total)	1.1	7.3	7.5	6.7	4.7
Pb (Total)	0.0	35.3	0.0	69.3	0.0
Mn (Total)	9.8	4.4	12.4	13.3	10.8
Mo (Total)	86.8	94.9	43.3	43.3	0.0

Table IV.1. Continued.

	u/s Smoky River		u/s Notikewin	Ft. Vermilion	
Variable	09/05/88	20/06/88	22/08/88	13/12/88	02/03/89
Ni (Total)	13.3	21.5	65.5	68.6	34.6
Se (Total)	13.3	17.3	0.0	31.5	57.7
V (Total)	37.8	74.0	88.2	65.5	0.0
Zn (Total)	45.8	5.0	72.1	17.3	0.0
Al (Diss.)	50.0	50.0	69.3	24.7	66.6
As (Diss.)	33.3	0.0	0.0	21.7	21.7
Ba (Diss.)	0.0	7.9	0.0	0.0	0.0
Bo (Diss.)	43.3	69.3	0.0	43.3	8.7
Cr (Diss.)	108.3	0.0	0.0	0.0	0.0
Cu (Diss.)	0.0	65.5	0.0	34.6	34.6
Fe (Diss.)	41.7	75.3	33.3	34.6	0.0
Mn (Diss.)	0.0	0.0	0.0	24.1	57.7
Mo (Diss.)	33.3	88.2	43.3	0.0	0.0
Ni (Diss.)	24.7	43.3	65.5	0.0	34.6
Se (Diss.)	24.7	34.6	0.0	122.5	86.6
Zn (Diss.)	5.6	56.7	72.1	17.3	50.0

Only compounds detected in one or more samples are listed.
To calculate statistics, values below detection limits were assumed to equal one-half the detection limit; CV was based on n = 3, for all cases.

IV.3 Field Blank Samples

Field blank samples contained distilled water from the analytical lab. The water was taken into the field and poured into regular sampling bottles on five different occasions in 1988-1989. Field blank samples provide a check for contamination as a result of sampling, handling, and laboratory analysis of the water samples.

Concentrations of most constituents in the field blank samples were below detection limits or were detected at low concentrations relative to those measured in surface water from the Peace River system (Table IV.2). However, total Kjeldahl nitrogen, organic carbon (dissolved and total), nickel, arsenic, oil and grease, and heterotrophic bacteria (Standard Plate Count) were detected in one or more field blanks at values similar to or higher than those measured in the surface water samples. Except for heterotrophic bacteria, there was no obvious source of contamination; one-time contamination during either the field sampling or laboratory analysis appears to be the most likely cause of the anomalies. The high heterotrophic bacterial counts were, however, probably due to contamination of the distilled water from the laboratory, since bacterial counts in the surface water were often lower than in the field blank samples.

Table IV.2. Results for field blank samples.

Constituent	Unit	Date				
		06/20/88	07/19/88	09/27/88	12/12/88	02/28/89
Ca	mg/L	0.16	0.2	0.07	0.09	0.5
Mg	mg/L	0.08	L0.01	0.22	0.05	L0.01
Cl	mg/L	L0.01	1.2	L0.01	0.40	L0.01
SO_4	mg/L	0.1	0.1	L0.1	2.7	L0.1
Total Alkalinity	mg/L	1.70	1.90	1.20	1.40	1.60
pH		5.61	5.35	5.36	5.22	5.36
HCO_3	mg/L	2.0	2.3	1.5	1.7	1.9
Total Hardness	mg/L	0.7	0.5	1.1	L0.5	1.2
SC	uS/cm	0.33	0.80	0.70	0.80	1.00
T&L	mg/L	L0.1	L0.1	L0.1	L0.1	0.1
Turbidity	NTU	0.2	0.2	0.2	0.4	1.2
True Colour	RCU	L5.	L5.	10	10	10
BOD	mg/L	L0.1	0.4	0.4	L0.1	0.3
Oil and Grease	mg/L	L0.1	0.5	L0.1	0.1	L0.1
CN	mg/L	L0.001	L0.001	0.001	L0.001	0.001
TOC	mg/L	L0.1	L0.1	9.2	L0.1	0.2
DOC	mg/L	L0.1	L0.1	8.6	L0.1	0.2
NH3-N	mg/L	L0.01	L0.01	0.02	L0.01	L0.01
TKN	mg/L	0.10	1.48	0.06	0.02	0.04
TDP	mg/L	0.003	L0.003	L0.003	L0.003	L0.003
TP	mg/L	L0.003	L0.003	0.003	L0.003	L0.003
TFR	mg/L	1	4	1	4	2
NFR	mg/L	L0.4	0.5	1.6	L0.4	L0.4
Std. Pl. Count	#/mL		5700	13000	280	600
Al (Total)	mg/L	L0.01	L0.01	L0.01	0.01	L0.01
As (Total)	mg/L	L0.0002	0.0015	L0.0002	L0.0002	L0.0002
Fe (Total)	mg/L	0.01	0.02	L0.01	L0.01	0.01
Mo (Total)	mg/L	L0.001	0.004	L0.001	0.002	L0.001
Ni (Total)	mg/L	0.002	0.028	0.001	L0.001	L0.001
V (Total)	mg/L	0.002	0.004	L0.001	L0.001	L0.001
Zn (Total)	mg/L	0.004	L0.001	L0.001	L0.001	0.001
Al (Diss.)	mg/L	L0.01	L0.01	L0.01	0.01	L0.01
Cd (Diss.)	mg/L	L0.001	0.001	L0.001	L0.001	L0.001
Fe (Diss.)	mg/L	L0.01	0.01	L0.01	L0.01	L0.01
Mo (Diss.)	mg/L	L0.001	L0.001	L0.001	0.002	L0.001
Ni (Diss.)	mg/L	0.001	0.004	0.001	L0.001	L0.001
V (Diss.)	mg/L	L0.001	0.002	L0.001	L0.001	L0.001
Zn (Diss.)	mg/L	0.006	L0.001	L0.001	L0.001	0.001

Only detected constituents are listed.
L Concentration less than, the number is the detection limit.

Appendix V. Water quality data, 1988-1989 synoptic surveys.

Station	Code	Date D/M/Y	Flow m3/s	Temp. Deg. C 02061	pH 10301	Total Alk. mg/L 10101	Total Hard. mg/L 10605	Cond. uS/cm 02041	TDS mg/L 00201	Ca mg/L 20103	Mg mg/L 12102	Na mg/L 11103	K mg/L 19103	HCO3 mg/L 06202	CO3 mg/L 06302	Cl mg/L 17203	SO4 mg/L 16306	Diss. F mg/L 09107	React. Silica mg/L 14105
PR nr border-c	008C07FD1050	09/05/88	1430	9.3	7.7	92.5	108.7	192	120	31	7.6	2.5	1.4	112.7	L.5	2	14.7	0.07	5.05
		20/06/88	2830	12.2	7.4	89.7	99.68	189	104	29.4	6.3	1.6	0.45	109	L.5	0.7	8.5	0.09	3.45
		21/07/88	2190	16	7.7	81.6	93.68	174	99	27.1	6.3	2	0.5	99.47	L.5	1.6	7.8	0.11	4.45
		22/08/88	1602	14.9	7.6	87.6	92.68	179	102	26.7	6.3	2	0.54	106.7	L.5	0.8	9.7	0.064	3.1
		03/10/88	1750	11.2	7.2	81.4	90.3	169	97	26.9	5.6	1.7	0.45	99.2	L.5	1.9	7.3	0.05	3.8
		12/12/88	1690	4.5	7.4	84.9	98.2	171	102	28.9	6.3	1.5	0.38	103.5	L.5	0.8	8.7	0.06	4.45
		28/02/89	1800	0.2	8.3	87.4	99.84	154	106	29.4	6.4	1.5	0.44	107	L.5	0.6	10	0.05	4.85
Pouce Coupe R.	00AL07FD0500	09/05/88	5.8	14.6	8.3	98.2	154.1	379	222	41.9	12	14.8	4.25	119.7	L.5	5	81.4	0.13	3.8
		20/06/88	10.1	15.4	7.8	95.8	134.0	294	173	36.5	10.4	11	2.75	116.7	L.5	2.1	47.8	0.12	5.2
		21/07/88	6.61	23.5	8	114	160.4	340	208	43.1	12.8	14.8	2.45	138.9	L.5	6.9	54.5	0.05	5.26
		22/08/88	0.692	16.6	8.1	197	320.2	836	539	82	28	65	4.73	240.1	L.5	6.5	234	0.23	0.3
		27/09/88	0.652	7.2	7.9	240	356.5	1088	725	83.2	36.1	110	7.4	277.6	7.32	20.4	323	0.3	0.36
		12/12/88	0.42	0.1	8	291	370.0	847	552	95	32.2	60	6.25	354.7	L.5	16	166	0.2	2.24
		28/02/89	0.019	0	7.3	638	608.2	1640	1126	133	67	169	5	777.7	L.5	33.3	327	0.24	9.1
PR nr Dunvegan-cmp	00AL07FD1600	09/05/88	1320	8.8	8.4	110	156.0	215	183	44.3	11	6.5	3.25	134.0	L.5	3.8	44	0.12	4
		20/06/88	2230	12.6	7.8	90.9	100.5	195	109	29.7	6.4	2	0.6	110.8	L.5	0.7	10.8	0.06	3.86
		21/07/88	1860	17.7	7.7	91	96.75	180	109	28	6.5	2.25	0.65	110.9	L.5	3.4	9.2	L.05	4.74
		22/08/88	1010	15.6	7.9	84.8	95.43	187	103	27.8	6.3	2.3	0.5	103.3	L.5	0.9	11.1	0.074	3.2
		27/09/88	1400	10.5	7.2	81.3	86.93	169	94	25.8	5.45	1.8	0.48	99.10	L.5	0.8	6.9	0.06	3.7
		12/12/88	1510	1.9	8	102	102.9	172	115	30.8	6.3	1.6	0.4	124.3	L.5	0.6	9.5	0.06	4.5
PR nr Dunvegan-c	00AL07FD1525	28/02/89	960	0	8.3	89.8	103.5	176	108	30.9	6.4	1.5	0.45	109.4	L.5	0.8	9.5	0.05	4.75
PR u/s Smoky R.-cmp	00AL07FD4600	09/05/88	1759	8.7	7.9	76.2	94.31	194	105	26.2	7	2.5	1.16	92.88	L.5	2.1	15	0.06	5.25
		09/05/88				74.2	94.8		104	27.7	6.2	2.4	1.1	90.4	L.5	1.9	15	0.06	5.2
		09/05/88				75.3	94		104	26.9	6.5	2.4	1.12	91.8	L.5	2.2	15	0.07	4.8
		20/06/88	2282	13.9	7.7	90.9	101.5	195	109	29.9	6.5	1.8	0.68	110.8	L.5	1.6	10.1	0.06	3.98
		21/07/88	1879	18.7	7.7	81.8	98.91	183	114	28.7	6.6	2.25	0.8	99.71	L.5	8.3	12.8	0.08	5
		22/08/88	972	16.6	8	86.4	103.5	185	115	30.7	6.5	2.3	0.5	105.3	L.5	8.8	10.8	0.064	3.1
		28/09/88	1467	9.8	7.8	81.3	86.56	169	96	25.9	5.3	1.9	0.5	99.10	L.5	1.9	7.8	0.05	3.8
		12/12/88	1510	0.3	8	84.1	99.26	170	103	29.5	6.2	1.6	0.4	102.5	L.5	0.9	9.5	0.06	4.45
PR u/s Smoky R.-c	00AL07FD4575	28/02/89	987	-0.1	8.31	89.3	100.5	174	107	29.7	6.4	1.5	0.44	108.8	L.5	0.9	9.5	0.05	4.8
P.R.Corr.Inst. STP	21AL07FD1000	09/05/88			7.17	42.2	170.2	553	278	50	11	34	8.25	51.44	L.5	31.2	118	0.22	0.6
		20/06/88			7.2	77.7	222	705	362	64.6	14.8	35.8	7.75	93.6	L.5	47	144	2.3	1.53
		21/07/88			8.07	62	248.5	693	360	67	19.7	40	10.3	75.57	L.5	33.1	153	0.28	L.02
		29/08/88			8.11	85	229	681	390	65.2	16.1	48	1	104	L.5	35.9	165	0.35	7.45
		28/09/88			7.19	34.2	210.4	662	355	63.6	12.5	43	9	41.7	L.5	63	140	0.26	3.2
		14/12/88			7.35	82.1	234.7	748	399	73.5	12.4	50	8.65	100.0	L.5	90	112	0.32	3.5
		01/03/89			7.51	45.5	160.5	538	254	47.1	10.4	34	11.4	55.46	L.5	41.6	79	0.33	3.3
Smoky R.	00AL07GJ4995	09/05/88	191	13.2	6.9	110	137.0	308	161	37.7	10.4	8.8	0.98	136.0	L.5	4.6	29.4	0.1	3.02
		20/06/88	708	17.1	7.7	86.8	100.8	202	113	29.3	6.7	4	0.93	105.8	L.5	1.3	14.5	0.1	3.98
		21/07/88	271	22	7.8	105	125.6	254	149	36.1	8.6	6.25	0.88	128	L.5	9.4	20.1	0.05	4.72
		22/08/88	168	18.4	8	108	136.2	286	160	38.7	9.6	7.25	0.65	131.6	L.5	5	31.5	0.096	2.4
		27/09/88	72.4	9	7.5	132	160.4	350	195	45.9	11.1	12	0.87	160.9	L.5	8.5	36.4	0.1	1.5
		12/12/88	29.7	0	8.2	196	267.9	540	340	77.2	18.2	22.9	1.01	238.9	L.5	20.6	78	0.14	4.6
		01/03/89	23.5	0	7.7	193	274.1	586	383	80.5	17.7	31.5	1.38	235.2	L.5	30.1	100	0.15	5.55
Grande Prairie STP	21AL07GE1000	09/05/88	0.046		8.13	252	226.2	1080	559	63	16.7	110	12.2	307.1	L.5	118	78	0.94	9.7
		20/06/88			7.51	171	214.3	970	528	55.8	18.2	110	12.3	209	L.5	124	96	0.88	9.41

Appendix V. Continued.

Station	Code	Date D/M/Y	Flow m3/s	Temp. Deg. C 02061	pH 10301	Total Alk. mg/L 10101	Total Hard. mg/L 10605	Cond. uS/cm 02041	TDS mg/L 00201	Ca mg/L 20103	Mg mg/L 12102	Na mg/L 11103	K mg/L 19103	HCO3 mg/L 06202	CO3 mg/L 06302	Cl mg/L 17203	SO4 mg/L 16306	Diss. F mg/L 09107	React. Silica mg/L 14105
Grande Prairie STP	21AL07GE1000	13/07/88			7.47	172	267.5	1000	560	67	24.3	103	11	209.6	L.5	128	115	0.94	8.3
		04/01/89	0.092		7.35	176	232.5	1100	567	60.8	19.6	109	14.5	214	L.5	132	116	0.92	10
		02/03/89	0.085	5.8	7.5	277	231	1136	613	63	18	122	12	338	L.5	129	98	1	5
P&G Effluent-grab	20AL07GE8000	11/05/88	0.713		7.2	243	667.5	3830	2632	242	15.2	695	18.8	296.2	L.5	957	547	0.12	11
		20/06/88			7.74	252	507.4	4230	2473	187	9.7	725	24.8	307.2	L.5	753	622		
		13/07/88	0.84		7.45	261	882.2	5090	2911	330	13.9	750	14.5	318.1	L.5	1160	482	0.2	3.98
		22/08/88	0.785		7.5	268	84[illegible]	5030	3084	322	14.8	740	20	327	L.5	1192	622	0.15	12.5
		19/09/88	0.731		7.45	250	667.6	4150	2594	244	14	690	21	304.7	L.5	1050	415	0.15	9.5
		15/12/88	0.749		7.18	217	913.3	4860	3100	339	16	6[illegible]2	13.2	264.5	L.5	1100	808	0.11	11.9
P&G Effluent-cmp	20AL07GE8001	02/03/89	0.696	20.7	7	286	990	6070	3862	365	19	1010	17	349	L.5	1360	908	0.15	11.7
Peace River STP	21AL07HA1000	10/05/88			7.91	247	155.0	827	441	41.6	12.4	79.5	10.4	301.0	L.5	37	95	0.94	16.7
		20/06/88			7.5	278	198	947	462	51.9	16.6	82	11.5	339	L.5	42.5	81.4	1.1	9.07
		21/07/88			8.3	297	279.0	1060	613	68	26.5	90	11.5	362.0	L.5	44	181	1	13.3
		22/08/88			7.61	278	201.5	843	477	51	18	72.5	11.5	338.8	L.5	49.9	95	1.03	12
		27/09/88			7.75	279	163.9	800	442	42.7	13.9	75	14	340.1	L.5	48.3	71	1.05	10
		12/12/88			7.23	232	147.8	806	400	40	11.6	65	10.9	282.8	L.5	52.5	68.5	1	12.6
		01/03/89			7.77	220	161.8	727	385	44.8	12.1	60.6	7.2	268.1	L.5	47	71	0.05	10.3
Peace River Oils	00AL07HA2400	17/05/88	0.04		9.66	2613	922.5	61600	31613	127	147	11500	158	1666.	747.6	18050	57.9	1.52	5
		04/10/88	0.04		7.73	2970	493.7		31567	19.7	108	12000	172	3620.	L.5	17400	81	1.75	4.3
		01/03/89	0.04		8.16	3130	847.2		32251	87	153	12600	154	3815.	L.5	17200	174	2.3	4.54
PR u/s Whitemud R.-cmp	00AL07HA2850	10/05/88	1950	9.2	8.2	93.7	109.4	207	123	31.1	7.7	4.3	0.85	114.2	L.5	2.8	16	L.05	4.35
		20/06/88	2990	15.1	7.7	88.9	100	199	110	29.3	6.5	2.8	0.68	108.3	L.5	1.3	11.8	0.08	3.98
		21/07/88	2150	19	7.7	85.9	102.9	196	118	29.8	6.9	3.5	0.8	104.7	L.5	7.5	13.3	0.05	4.97
		22/08/88	1140	17.8	8.1	87.8	101.1	201	111	29.1	6.9	3.75	0.5	107.0	L.5	2.7	13.1	0.064	2.6
		28/09/88	1540	9.7	7.8	84.6	88.38	184	102	26.3	5.5	3.5	0.54	103.1	L.5	2.5	9.6	0.05	3.7
		12/12/88	1540	0.2	8	89.9	106.3	188	115	31.5	6.7	3.1	0.4	109.5	L.5	2.7	12	0.06	4.35
PR u/s Whitemud R.-c	00AL07HA2820	01/03/89	1010		7.28	91	101.8		115	30.2	6.4	2.8	0.43	110.9	L.5	2.3	13.3	0.05	4.8
Whitemud R.	00AL07HA3000	09/05/88	7.28	12.5	8	71	110.6	270	157	30.1	8.6	10.7	2.51	86.54	L.5	2.9	54.6	0.12	4.6
		20/06/88	13.2	18.9	7.7	89.5	166.6	372	225	47.4	11.7	12.8	2.3	109.1	L.5	1.9	89.5	0.16	5.2
		21/07/88	30.7	21.3	7.7	90.5	160.4	318	239	45.7	14.7	11.5	1.95	110	L.5	33.9	73	0.13	7.3
		22/08/88	6.89	19.7	8.1	135	180.6	380	233	51	12.9	11	1.5	164.5	L.5	2.9	66	0.16	6.9
		28/09/88	1.27	5.4	7.8	148	195.1	456	288	54.5	14.3	23.3	1.6	180.4	L.5	2.9	99	0.19	3.3
		12/12/88	0.611	0	7.8	194	281.9	598	393	78.2	21	33.1	2.02	236.4	L.5	4	130	0.21	8.32
		01/03/89	0.146	-0.4	8.4	223	352.3	620	583	95	27.9	65	2.53	271.8	L.5	10.3	241	0.25	7.9
Cadotte R.	00AL07HB1000	09/05/88	3.17	13	8.4	106	137.4	296	163	38.5	10	7.4	2.5	129.2	L.5	3.4	33	0.12	4.1
		20/06/88	20.1	19.1	8	116	150.6	297	170	44.6	9.5	5.5	1.88	141.4	L.5	1.4	33.2	0.13	4.01
		21/07/88	24.7	20.9	7.7	107	147.3	267	174	43	9.8	4.25	1.95	130.4	L.5	13.4	30	0.11	7.3
		22/08/88	0.805	19.5	8.3	148	161.6	331	189	46.7	10.9	10.3	1.6	180.4	L.5	3.5	24.5	0.15	2.45
		28/09/88	0.294	5.3	7.6	194	200.1	570	347	57.5	13.7	48	2	236.4	L.5	21.4	87	0.16	0.9
		12/12/88		-0.3	8.1	220	253.3	505	317	72.7	17.4	23.5	2.37	268.1	L.5	9.8	50.9	0.17	8.67
		01/03/89	0.507	-0.4	8.1	262	289.8	648	410	82.5	20.3	38.8	3.1	319.3	L.5	18	78.5	0.2	11.5
PR u/s Notikewin R.-c	00AL07HC1200	10/05/88	1850	8.6	8.8	90.4	106.7	202	117	30.2	7.6	3.5	1.05	110	L.5	2.1	14.4	0.1	4.4
		20/06/88	3270	15.4	7.7	89.1	100.7	201	111	29.6	6.5	2.75	0.75	108.6	L.5	1.4	12.8	0.08	4.18
		20/06/88				89.2	101		111	29.7	6.5	2.75	0.75	108.7	L.5	1.3	12.2	0.06	4.2
		20/06/88				90.3	101.8		112	30	6.5	2.75	0.73	110.1	L.5	1.3	12.8	0.06	3.86
		19/07/88	2530	15.8	7.6	83.3	108.2	203	125	30.8	7.6	4	1.4	101.5	L.5	7.7	17.9	0.08	5.2

Appendix V. Continued.

Station	Code	Date D/M/Y	Flow m3/s	Temp. Deg. C 02061	pH 10301	Total Alk. mg/L 10101	Total Hard. mg/L 10605	Cond. uS/cm 02041	TDS mg/L 00201	Ca mg/L 20103	Mg mg/L 12102	Na mg/L 11103	K mg/L 19103	HCO3 mg/L 06202	CO3 mg/L 06302	Cl mg/L 17203	SO4 mg/L 16306	Diss. F mg/L 09107	React. Silica mg/L 14105
PR u/s Notikewin R.-c	00AL07HC1200	22/08/88	1250	17.3	8	85.2	98.50	200	108	28.7	6.5	3.5	0.5	103.8	L.5	2.2	12.9	0.074	3
		22/08/88				85.4	100.1		109	28.5	7	3.25	0.5	104.1	L.5	2.2	12.9	0.07	2.9
		22/08/88				88.1	102.7		111	29.4	7.1	3.5	0.55	107.4	L.5	2.2	12.9	0.1	2.9
		28/09/88	1680	9.6	7.3	83.8	87.22	182	101	26	5.4	3.2	0.52	102.1	L.5	2.9	9.3	0.19	3.76
		13/12/88	1380	0.3	8	91.6	106.0	188	115	31.4	6.7	3	0.44	111.6	L.5	2.4	11.2	L.05	4.6
		01/03/89	1100	-0.2	8.3	92.5	102.8	188	116	30.6	6.4	2.7	0.48	112.7	L.5	2.2	13.1	0.05	4.85
Notikewin R.	00AL07HC1400	10/05/88	42.1	9.2	7.6	56	74	166	104	20.1	5.8	7.4	1.86	68	L.5	1.8	28.8	0.08	5.1
		20/06/88	38.9	19.9	7.7	66.9	107.3	247	146	30.6	7.5	8.75	1.3	81.55	L.5	1.9	50.1	0.11	5.76
		19/07/88	158	16	7.4	64.7	110.5	216	151	30.9	8.1	8.5	1.65	78.86	L.5	11.3	44.7	0.1	6.82
		22/08/88	43.9	19.5	7.9	84	119.2	309	168	32.9	9	12	1.35	102.4	L.5	2.4	52.6	0.14	7.3
		28/09/88	5.61	7.1	7.2	128	162.5	371	234	46.1	11.5	19	1.5	156	L.5	2.7	73	0.13	3
		13/12/88	1.84	0	8.1	187	246.1	526	352	68.5	18.2	32	1.88	227.9	L.5	4.8	106	0.14	8.7
		01/03/89	0.356	-0.3	8.2	314	386.8	745	625	106	29.6	67.5	3.17	382.7	L.5	17	202	0.25	11.2
PR nr Carcajou-c	00AL07HD1030	10/05/88		8.5	8.2	87.5	104.8	194	115	30.1	7.2	3.2	0.88	106.6	L.5	1.7	15.4	L.05	4.4
		21/06/88		15.1	7.6	90.2	100.2	201	113	29.4	6.5	3	0.78	109.9	L.5	1.6	12.9	0.08	4.4
		19/07/88		16.1	7.6	82.1	107.3	206	128	30.9	7.3	4.25	1.58	100.0	L.5	8.6	21.1	0.08	5.31
		23/08/88		16.7	7.9	87.9	102.4	203	113	29.3	7.1	3.6	0.52	107.1	L.5	2.1	14.6	0.064	2.95
		28/09/88		9.6	7.4	82.6	88.63	181	101	26.4	5.5	3.1	0.51	100.6	L.5	2.5	9.4	0.05	3.7
		13/12/88		0	8.2	95.1	111.8	200	121	33.2	7	3.3	0.45	115.9	L.5	2.7	12.8	L.05	4.58
		01/03/89		-0.3	8.1	92.2	103.5	190	115	30.7	6.5	2.9	0.5	112.3	L.5	2.7	11.9	0.05	4.9
Wolverine R.	00AL07HE1000	10/05/88	15	9.2	7.9	96.6	125.0	248	153	35.7	8.7	6.4	2.38	117.7	L.5	1.6	37	0.1	3.7
		21/06/88	4.07	16.6	7.8	120	165.8	345	202	48.4	10.9	9.5	1.95	146.2	L.5	1.7	52.6	0.13	4.58
		19/07/88	86.9	16.8	7.3	118	162.9	310	189	46.9	11.1	7	1.6	143.8	L.5	7.4	36.9	0.11	7.2
		23/08/88	1.62	15.9	7.9	126	156.5	322	190	44.5	11	9.7	1.8	153.5	L.5	1.7	37.1	0.14	8.15
		28/09/88	2.45	6.5	7.5	143	150.2	334	191	46.5	10.7	10.9	1.8	174.3	L.5	2.2	32.9	0.12	0.16
		13/12/88		-0.2	7.7	200	219.4	447	265	59.8	17	13.5	2	243.8	L.5	3.1	41.7	0.1	8.1
Keg R.	00AL07HF1300	10/05/88	15.9	8	7.8	81.8	112.0	261	167	31.8	7.9	15	3.46	99.71	L.5	2.9	51.2	0.17	5.36
		21/06/88	5.65	16.5	7.8	103	139.0	355	205	40.3	9.3	14.5	2.2	125.5	L.5	3.5	67.1	0.19	6.08
		19/07/88	12.8	17.9	7.6	95.9	130.0	297	188	36.7	9.3	17	2	116.9	L.5	11.3	47.2	0.13	6.78
		23/08/88	3.22	16.3	8.1	182	220.5	478	296	64	14.7	25.5	2.3	221.8	L.5	4.7	69	0.22	6.95
		28/09/88	6.93	7.4	7.4	207	231.4	530	331	66.9	15.6	26.4	3	252.3	L.5	6.4	84	0.22	4
		13/12/88		-0.1	8.1	242	287.6	595	391	81.3	20.5	32.5	3.25	295	L.5	4.9	95.5	0.17	8.25
		01/03/89	0.084	-0.1	8.1	323	370.3	731	468	104	26.8	30	5.3	393.7	L.5	11.5	87	0.22	10
PR nr La Crete-c	00AL07HF1530	10/05/88		8.4	6.7	88.9	108.7	196	119	31.3	7.4	3.4	0.92	108.3	L.5	1.9	16.2	0.05	4.45
		21/06/88		15.6	7.6	87.7	100	205	112	29.3	6.5	3.25	0.9	106.9	L.5	1.6	13.3	0.09	4.52
		19/07/88		16.2	7.2	86	112.8	214	143	32.3	7.8	4.5	1.9	104.8	L.5	15.7	23.1	0.09	5.95
		23/08/88		17.3	7.9	87.3	104.2	204	113	30	7.1	3.7	0.55	106.4	L.5	2.2	14.1	0.074	3.05
		28/09/88		9.5	7.4	83.9	88.13	183	101	26.2	5.5	3	0.55	102.2	L.5	2.5	9.4	0.06	3.56
		13/12/88		0	8.3	96.2	114.3	203	124	33.7	7.3	3.5	0.45	117.2	L.5	2.6	13.8	L.05	4.42
		02/03/89		0	8.3	92.1	105	186	115	31.3	6.5	2.7	0.47	112.2	L.5	2	11.8	L.05	4.77
PR nr Ft. Vermilion-c	00AL07HF1720	11/05/88	2620	8.7	7.9	88.2	99.09	197	116	26.3	8.1	3.5	0.95	107.5	L.5	2.4	17	L.05	4.35
		21/06/88	3510	16.4	7.4	89.2	99.34	206	114	29.2	6.4	3.25	1.05	108.7	L.5	1.4	14.3	0.13	4.51
		19/07/88	3750	17.4	7.2	88	117.2	220	148	33.4	8.2	5	4.6	107.2	L.5	13.7	24.2	0.09	5.76
		23/08/88	1620	17.3	7.9	87.5	100.5	201	111	29.2	6.7	3.5	0.55	106.6	L.5	2.2	13.4	0.074	3.05
		29/09/88	1660	9.8	7.6	69.5	109.4	183	148	31.6	7.4	11.6	1.1	84.72	L.5	5.3	45.4	0.1	4.2
		13/12/88	1330	-0.2	8.3	98.8	116.9	211	128	34.6	7.4	4	0.5	120.4	L.5	2.9	14.7	L.05	4.55

Appendix V. Continued.

Station	Code	Date D/M/Y	Flow m3/s	Temp. Deg. C 02061	pH 10301	Total Alk. mg/L 10101	Total Hard. mg/L 10605	Cond. uS/cm 02041	TDS mg/L 00201	Ca mg/L 20103	Mg mg/L 12102	Na mg/L 11103	K mg/L 19103	HCO3 mg/L 06202	CO3 mg/L 06302	Cl mg/L 17203	SO4 mg/L 16306	Diss. F mg/L 09107	React. Silica mg/L 14105
PR nr Ft. Vermilion-c	00AL07HF1720	13/12/88				99.3	115.7		129	34.1	7.4	4.1	0.5	121	L.5	3	15.8	L.05	4.8
		13/12/88				98.3	116.9		127	34.4	7.5	4.1	0.52	119.8	L.5	2.9	13.4	L.05	4.8
		02/03/89	1200	-0.2	8.4	92	105.5	188	115	31.5	6.5	2.5	0.46	112.1	L.5	2	12.1	L.05	4.87
		02/03/89				92.6	103.6		115	30.6	6.6	2.4	0.45	112.8	L.5	2.1	12.1	0.06	4.8
		02/03/89				93	103.4		115	30.5	6.6	2.4	0.45	113.3	L.5	2.1	11.9	L.05	4.8
Ft. Vermilion STP	21AL07HF1000	24/05/88				166	139.2		289	36.6	11.6	42.5	8	202.3	L.5	32.5	50	0.13	7.8
Boyer R.	00AL07JF1000	10/05/88	157	5.4	7.9	86.1	124.2	226	162	36.7	7.9	9.8	3.5	104.9	L.5	4.7	44.5	0.15	3.55
		21/06/88	42.8	17	7.5	97.8	135.4	336	194	36.9	10.5	17.3	2.28	119.2	L.5	7.7	57.2	0.12	3.39
		19/07/88	48	19.2	7.3	125	170.6	398	245	44.4	14.5	21.5	2.45	152.3	L.5	20.4	62.1	0.11	5.12
		23/08/88	14.4	16.3	7.6	71	141.9	322	230	39.5	10.5	18.8	1.7	86.6	L.5	35.9	76	0.18	4.5
		29/09/88	5.17	5.2	7.4	84.5	91.96	242	103	27.4	5.7	3	0.55	103.0	L.5	2.4	9.6	0.06	3.6
		13/12/88		-0.2	7.5	184	273.8	604	390	71.5	23.1	35.6	2.63	224.3	L.5	18.2	122	0.11	6.45
		02/03/89	0.221	0.1	7	312	507.8	1148	807	134	42	73	4.5	380.3	L.5	48.3	308	0.2	9.65
Wabasca R.	00AL07JD1000	11/05/88	134	8.6	8.7	79	96.34	221	128	25.2	8.1	8	1.93	96.30	L.5	2.2	31.6	0.11	3.35
		21/06/88	224	18.7	7.4	76.5	95.59	208	120	27.7	6.4	7	1.15	93.25	L.5	1.8	25.1	0.09	4.53
		19/07/88	952	17.5	7.1	92.1	136.7	284	188	38.4	9.9	12.3	2.25	112.2	L.5	11.5	51	0.18	7.69
		23/08/88	137	18.4	7.9	112	132.2	275	157	36.1	10.2	8.9	1.6	136.5	L.5	2.1	26.6	0.15	4.1
		29/09/88	73.6	7.7	7.6	116	133.6	281	164	38.3	9.2	10.2	1.7	141.4	L.5	2.6	28.9	0.13	3.66
		14/12/88	27.7	0.2	7.5	162	188.1	356	235	53.7	13.1	15	2.06	197.4	L.5	3.2	43.1	0.11	7.9
		02/03/89	9.81	-0.1	7.5	202	220.0	485	315	62	15.8	22.2	2.55	246.2	L.5	10.8	71	0.18	9.2
Mikkwa River	00AL07JE1000	19/07/88	18.6	17.5	7	67.8	96.2	183	121	27.3	6.8	7	1	83	L.5	8.4	24.2	0.09	6.02
		23/08/88	18.3	18.5	7.8	107	125.8	262	165	35.5	9	9.4	1.1	130.4	L.5	4.6	23.2	0.13	7.6
		14/12/88		0.3	7.4	121	145.3	304	219	40.5	10.7	13.5	1.39	148	L.5	5.3	33.9	0.06	10
		02/03/89	0.756	0	7.8	187	212.2	560	246	60	15.1	20.2	1.68	228	L.5	9.8	65	0.12	11
Wentzel R.-mouth	00AL07KA1500	11/05/88	90.1	3.5	7.1	60.8	71	116	86	19.8	5.3	3.5	0.95	66.9	L.5	1.9	16	0.05	2.48
Wentzel R.-Hwy.58	00AL07KA1000	21/06/88	29	13.6	7.5	51.6	59.96	120	76	17.4	4	3.75	0.7	63	L.5	1.2	13.7	0.09	4.49
		19/07/88	29.7	17.4	7	54.5	77.96	156	95	21.8	5.7	5.25	0.65	66.43	L.5	5.7	20.1	0.06	2.74
Wentzel R.-mouth	00AL07KA1500	23/08/88	12.3	14.2	7.5	66	94.6	193	115	26.5	6.9	5.3	0.55	80.5	L.5	3.4	28.8	0.11	3.85
		29/09/88	4.93	4.1	7.3	77.4	101.9	214	126	29.6	6.8	8.4	0.74	94.35	L.5	4.1	26.9	0.09	3.4
		14/12/88		-0.2	7.7	117	149.8	333	198	42.8	10.4	17.1	1.14	142.6	L.5	11.9	40.6	0.08	4.12
		02/03/89	0.127	0.1	7.3	256	321.8	818	491	94	21.1	54	2.1	312.0	L.5	62.5	97	0.15	6.2
PR u/s Wood Buffalo-c	00AL07KA2000	11/05/88		8.2	7.4	89.1	99.25	206	120	26.2	8.2	4	1.16	108.8	L.5	2.5	20	0.07	4.3
		21/06/88		16.8	7.5	87.1	98.09	204	117	28.7	6.4	4	1.28	106.1	L.5	1.7	17.7	0.11	5.3
		19/07/88		17.7	7	85.2	125.2	232	168	36.1	8.5	7.25	2.35	103.8	L.5	23	33.2	0.11	6.64
		23/08/88		18.3	7.9	91.3	106.2	214	119	31.3	6.8	4.4	0.67	111.3	L.5	2.5	15.2	0.09	2.9
		29/09/88		8.7	7.6	89.6	99.18	198	112	29.3	6.3	4	0.6	109.2	L.5	2.1	12.4	0.06	3.4
		14/12/88		-0.2	8.1	93.4	110.8	203	122	32.8	7	4	0.62	113.8	L.5	2.5	14.6	L.05	4.7
		02/03/89		-0.1	8.2	93.5	104.6	190	117	31	6.6	2.7	0.46	113.9	L.5	2.3	13.1	L.05	4.86
PR nr Peace Point-c	00AL07KC1000	11/05/88	3120	8.4	7.8	99.7	103.4	212	130	27.7	8.3	4.5	1.21	121.5	L.5	2.7	21.4	0.07	4.22
		21/06/88	4500	17.1	7.4	89.9	105.8	217	128	31.3	6.7	5	2	109.5	L.5	1.7	22.1	0.22	5.19
		19/07/88	5100	18.4	7	89.3	117.5	232	147	33.7	8.1	6	1.6	108.8	L.5	12.3	26.1	0.1	5.57
		23/08/88	1860	18.7	7.9	92.5	107.7	219	122	31.4	7.1	4.6	0.67	112.8	L.5	2.7	16.4	0.07	3.25
		29/09/88	1750	8.9	7.7	88.3	97.10	196	110	28.8	6.1	3.7	0.58	107.6	L.5	1.9	12.4	0.06	3.5
		14/12/88	1550	0	8.1	98.1	116.4	208	128	34.4	7.4	4	0.62	119.5	L.5	2.9	14.9	L.05	4.75
		02/03/89	1300	0	8.2	92.9	104.6	190	117	31	6.6	2.6	0.48	113.2	L.5	2.4	13.1	L.05	4.84

Appendix V. Continued.

Station	Code	Date D/M/Y	DO mg/L 08102	BOD mg/L 08202	Susp. Solid mg/L 10401	Filt. Residue mg/L 10451	Turb. NTU 02074	True Color RCU 02021	Tann. & Lig. mg/L 06551	Oil & Grease mg/L 06521	Phenol mg/L 06537	DOC mg/L 06104	TOC mg/L 06005	Total P mg/L 15406	Diss. P mg/L 15103	Total NH3 mg/L 07505	NO2+NO3 mg/L 07110	TKN mg/L 07015	Total N mg/L 07602	Phyto. Chla mg/m3 06715	Epil. Chla mg/m2 06722
PR nr border-c	00BC07FD1050	09/05/88	10.3	0.3	176	120	192	30		L.1	0.003	7.5	8.2	0.29	0.009	0.07	0.05	0.64	0.69	1	14.4
		20/06/88	10.7	L.1	42.4	100	31	5	0.25	0.1	L.001	2.8	3	0.092	0.005	L.01	0.017	0.26	0.277	1.5	
		21/07/88	9.1	0.2	39	100	38	30	0.77	0.5	0.001	4.5	4.7	0.058	0.007	0.03	0.025	0.36	0.385	1.2	15.2
		22/08/88	9.8	0.6	14	100	7.4	30	0.22	0.4	L.001	3.2	3.5	0.014	0.005	0.02	0.007	0.3	0.307	5.3	26.2
		03/10/88	10.6	2.8	9.2	94	6.4	40	0.3	0.3	L.001	3.4	3.6	0.01	0.004	L.01	0.02	0.5	0.52	4.1	63.5
		12/12/88	11.4	0.2	3.2	100	3	20	0.5	2.5	L.001	2.7	2.8	0.008	0.003	L.01	0.053	0.2	0.253	1.4	
		28/02/89	13.6	0.5	3.06	100	2	20	0.3	0.2	0.003	2	2.2	0.007	0.003	0.01	0.042	0.2	0.242	1	
Pouce Coupe R.	00AL07FD0500	09/05/88	9.6	1.5	162	220	174	60		L.1	0.006	20.2	20.5	0.166	0.02	0.05	0.005	1.14	1.145	10.2	
		20/06/88	9.7	1.2	144	170	136	120	2.55	0.1	0.007	25.5	26	0.165	0.029	0.04	0.049	1.34	1.389	1.9	
		21/07/88	8.3	0.4	38	200	65	100	2.78	0.5	0.006	26.7	27.3	0.082	0.022	0.05	L.003	1.14	1.143	11	
		22/08/88	9.6	0.6	11.5	540	18	40	0.89	0.3	L.001	16	17	0.017	0.008	0.03	L.003	0.8	0.803	4.3	
		27/09/88	10.7	0.9	10.4	730	4.8	30	0.958	2.12	L.001	18.1	18.7	0.018	0.01	0.02	L.003	0.6	0.603	5.8	
		12/12/88	11.4	L.1	1.95	550	14	50	1.58	0.56	0.007	22.7	24	0.039	0.012	0.35	0.65	1.36	2.01	0.3	
		28/02/89	2.8	1.7	20.6	1120	12	20	0.5	0.3	0.001	9.2	9.3	0.047	0.006	0.59	0.079	1.14	1.219	0.7	
PR nr Dunvegan-cmp	00AL07FD1600	09/05/88	10.1	1	830	180	510	30		L.1	0.004	13.6	14.8	0.42	0.01	0.07	0.021	1.52	1.541	15.7	23.8
		20/06/88	10.5	L.1	75	110	57	20	0.41	0.1	L.001	1.6	1.8	0.08	0.004	L.01	0.021	0.32	0.341	1.4	
		21/07/88	9.2	0.3	91	110	67	40	0.96	0.5	0.001	6.5	6.7	0.09	0.01	0.02	0.028	0.3	0.328	1.2	2.1
		22/08/88	9.9	0.4	9	100	8.2	20	0.22	0.5	L.001	3.9	4.2	0.012	0.008	0.01	L.003	0.22	0.223	2.1	99.1
		27/09/88	10.4	0.7	9.2	90	3.8	20	0.35	0.87	L.001	3.6	4	0.013	0.005	L.01	0.016	0.18	0.196	2.9	35.4
		12/12/88	12.7	0.14	4.4	110	3.2	20	0.272	0.38	0.001	2.5	3	0.007	0.003	L.01	0.047	0.18	0.227	1.5	
PR nr Dunvegan-c	00AL07FD1525	28/02/89	13.2	0.3	2.13	105	1.4	10	0.7	0.3	0.002	2.4	2.4	0.007	0.003	L.01	0.043	0.2	0.243	0.6	
PR u/s Smoky R.-cmp	00AL07FD4600	09/05/88	11.3	0.3	154	100	152	30		L.1	0.002	7	7.8	0.135	0.008	0.04	0.05	0.62	0.67	1.1	14.3
		09/05/88		1.1	154	100	158	30		L.1	0.002	6.5	7	0.148	0.007	0.03	0.045	0.72	0.765	1	
		09/05/88		0.8	184	100	156	30		L.1	0.002	7.6	9.2	0.14	0.007	0.03	0.046	0.54	0.586	1.2	
		20/06/88	10.3	L.1	109.2	110	94	20	0.57	0.2	L.001	4	4.2	0.125	0.005	0.01	0.024	0.36	0.384	1.4	
		21/07/88	8.7	1.6	808	110	268	60	1.13	0.5	0.001	6	6.5	0.59	0.012	L.01	0.044	0.84	0.884	1.6	
		22/08/88	9.9	0.7	12	110	11	10	0.23	0.3	L.001	3.8	4	0.011	0.009	0.01	L.003	0.26	0.263	2.1	68.6
		28/09/88	9.9	0.4	4	93	2.1	20	0.38	0.33	L.001	4	4.1	0.008	0.003	L.01	0.012	0.2	0.212	2.4	32.6
		12/12/88	13.3	L.1	5.6	100	0.24	20	2.4	0.38	0.001	2.6	2.7	0.007	L.003	L.01	0.047	0.12	0.167	2.1	
PR u/s Smoky R.-c	00AL07FD4575	28/02/89	13	0.6	114	100	42	10	0.3	0.2	0.001	2.3	2.3	0.027	L.003	L.01	0.046	0.22	0.266	1.8	
P.R.Corr.Inst. STP	21AL07FD1000	09/05/88		1.8	5	300	1.4	L5.		L.1	0.004	5.8	6	1.85	1.7	0.06	16.8	0.1	16.9		
		20/06/88		0.9	26.4	360	2.3	L5.	0.2	0.5	0.006	6.6	7	1.84	1.8	0.06	20.4	0.96	21.36		
		21/07/88		5.8	10.4	380	5.4	5	0.77	1.1	0.003	6.6	8.1	1.88	1.8	0.12	18.3	1.64	19.94		
		29/08/88		3.8	3.6	380	2	5	0.5	0.6	0.001	7.3	7.7	2.7		0.09		1.12			
		28/09/88		0.9	0.8	370	0.8	10	0.4	0.8	L.001	5.7	6.3	1.9		0.05		0.68			
		14/12/88		4.8	L.4	410	1.6	40	0.3	0.65	0.001	6.6	6.7	0.8	0.7	0.05	13.6	0.88	14.48		
		01/03/89		7.8	2.53	270	2.6	20	0.5	1.2	0.006	10.3	10.3	2.2	2	0.11	16.6	1.44	18.04		
Smoky R.	00AL07GJ4995	09/05/88	9.9	1.4	36	160	42	30		L.1	0.002	5.5	5.6	0.054	0.006	0.08	0.005	0.46	0.465	2.1	
		20/06/88	9.3	0.6	331	110	168	50	0.93	0.6	0.001	7.5	7.8	0.23	0.01	0.04	0.02	0.78	0.8	0.8	
		21/07/88	8.3	0.1	119	150	84	60	1.24	0.5	0.001	9.1	9.6	0.094	0.011	0.03	L.003	0.48	0.483	1.9	
		22/08/88	9	0.4	35.5	160	29	20	0.29	0.3	L.001	2.8	3.1	0.033	0.004	L.01	L.003	0.2	0.203	1.1	
		27/09/88	10.9	0.7	11.2	190	7.2	30	0.547	0.54	L.001	4.9	5	0.016	0.004	L.01	L.003	0.18	0.183	0.8	
		12/12/88	13.3	L.1	3.6	340	5	50	1.95	0.76	0.013	5	6.3	0.018	0.01	0.04	0.063	0.28	0.343	0.1	
		01/03/89	7	1.2	23.3	380	3.2	100	3.6	1.3	0.019	7.7	8.2	0.042	0.031	0.13	0.137	0.56	0.697	0.1	
Grande Prairie STP	21AL07GE1000	09/05/88		13.5	10.4	560	6.3	30		L.1	0.009	13	13.2	5.2	4.9	11.8	2.52	15.4	17.92		
		20/06/88		2.9	47	540	9.1	30	1.3	0.5	0.006	12.6	13.4	5.6	5	8.2	13.1	11	24.1		

Appendix V. Continued.

Station	Code	Date D/M/Y	DO mg/L 08102	BOD mg/L 08202	Susp. Solid mg/L 10401	Filt. Residue mg/L 10451	Turb. NTU 02074	True Color RCU 02021	Tann. & Lig. mg/L 06551	Oil & Grease mg/L 06521	Phenol mg/L 06537	DOC mg/L 06104	TOC mg/L 06005	Total P mg/L 15406	Diss. P mg/L 15103	Total NH3 mg/L 07505	NO2+NO3 mg/L 07110	TKN mg/L 07015	Total N mg/L 07602	Phyto. Chla mg/m3 06715	Epil. Chla mg/m2 06722
Grande Prairie STP	21AL07GE1000	13/07/88		21.1	6.8	560	5.4	30	0.87	0.8	0.004	12.2	12.4	4.7	4.5	6	5.3	10.2	15.5		
		04/01/89		6	4.67	570	3.4	40	1.1	1.9	0.008	12.5	12.5	5		10.3	4.8	13.6	18.4		
		02/03/89	2.5	10.3	5			36	1.74	0.78	0.017	14.4		5.9		13.6	1.83	16	17.83		
P&G Effluent-grab	20AL07GE8000	11/05/88		30.9	172	2620	83	2000		0.2	0.42	245	252	0.66	0.38	0.07	0.07	8	8.07		
		20/06/88		10	58	2480	48	2000	48.9	1.8	0.18	170	185	0.58	0.44	2.5	0.11	13.8	13.91		
		13/07/88		94.2	214	2910	100	2000	41	7.9	0.6	280	296	1.4	0.52	0.26	0.11	8.5	8.61		
		22/08/88		43	200	3075	160	600	7.7	5.7	0.09	33	34	1.48	0.56	0.09	0.34	7	7.34		
		19/09/88		90	166	2590	110	20000	112	10.3	0.012	240	224	1.22	0.66	0.08	0.108	6.82	6.928		
		15/12/88		40.8	120	3090	62	600	102	4.87	0.43	210	231	0.88	0.7	2.2	0.1	11	11.1		
P&G Effluent-cmp	20AL07GE8001	02/03/89	0.8	87	236		149	2450	87	1.86	1.25	334		2.02		1.7	0.16	10	10.16		
Peace River STP	21AL07NA1000	10/05/88		98	29	455	19	50		4.1	0.078	40	42	6.2	5.7	26	0.009	26.4	26.40		
		20/06/88		93.9	47	470	22	80	2.76	6.5	0.093	24.5	25	6.4		19		19.8			
		21/07/88		107	22	620	39	50	4.83	4.7	0.069	21.8	24.8	6.3	6	20.3	0.66	26.6	27.26		
		22/08/88		123	28.5	490	16	50	5.42	6.1	0.051	28.8	29.2	6.4	5.5	22	L.003	22.4	22.4		
		27/09/88		192	34.8	460	22	50	4.85	1.16	0.053	36	39.5	6.8	5.9	24	0.009	24.5	24.50		
		12/12/88		113.9	40.9	410	48	50	6.88	25	0.082	35.7	36.6	6.9	6.3	20	0.013	33.4	33.41		
		01/03/89		47.6	20.4	390	20	30	3.3	20.3	0.038	11	11.3	4.4	4	12.9	0.005	17.6	17.60		
Peace River Oils	00AL07NA2400	17/05/88			50	31650	1.9	L5.			0.15	6.6	7	0.012		27	L.003	28	28		
		04/10/88			10.8	31600	0.44	20		3.32	0.002	8.7	9.3	0.007		25.5		27.8			
		01/03/89			15.6	32300	20	10		3.6	0.16	6.2	7.1	0.01		16		27.2			
PR u/s Whitemud R.-cmp	00AL07NA2850	10/05/88	10.4	1.1	131	120	134	30		L.1	0.003	7.2	7.6	0.16	0.01	0.04	0.04	0.7	0.74	1.2	1.7
		20/06/88	9.8	0.6	146	110	97	20	0.74	0.2	0.001	5.3	5.4	0.134	0.008	0.01	0.019	0.46	0.479	1.3	
		21/07/88	8.9	0.3	153	110	118	50	1.19	0.6	0.001	7.4	7.4	0.136	0.011	0.05	0.027	0.48	0.507	1.3	1
		22/08/88	9.8	0.4	8	110	4.8	20	0.3	0.3	L.001	2.9	3.2	0.024	0.004	L.01	L.003	0.2	0.203	2.1	49.9
		28/09/88	9.9	0.5	4	100	3.4	20	0.33	0.43	L.001	4.3	4.6	0.009	0.003	L.01	0.013	0.2	0.213	2.4	7.3
		12/12/88	13.7	1.05	3.6	110	3.2	30	0.32	0.37	L.001	2.6	2.8	0.006	L.003	L.01	0.046	0.16	0.206	1.4	
PR u/s Whitemud R.-c	00AL07NA2820	01/03/89	13.1	1.1	L.4	110	1.2	20	0.3	0.3	0.001	2.6	2.8	0.011	0.008	0.01	0.042	0.2	0.242	0.5	
Whitemud R.	00AL07NA3000	09/05/88	9.8	1.5	488	150	220	50		L.1	0.007	16.6	18.5	0.29	0.025	0.08	0.022	1.38	1.402	6.6	
		20/06/88	9	1.7	534	220	252	100	2.16	0.7	0.008	24.8	25	0.5	0.025	0.1	0.023	1.5	1.523	1.7	
		21/07/88	8.5	0.6	884	210	488	120	2.63	0.8	0.005	27.3	28.4	0.84	0.046	0.16	0.016	1.08	1.096	6.4	
		22/08/88	8.9	1	165.5	230	112	70	0.9	0.3	L.001	18.6	19.2	0.2	0.013	0.05	L.003	0.96	0.963	8.6	
		28/09/88	11.2	0.5	3.2	285	14	70	1.3	0.5	L.001	20.5	21.1	0.036	0.007	0.03	L.003	0.62	0.623	1	
		12/12/88	14	0.21	6.8	390	18	50	1.5	0.56	0.005	18.7	19	0.057	0.005	0.11	0.076	0.68	0.756	0.5	
		01/03/89	13.2	1.8	13.1	580	12	20	0.9	0.3	0.001	9.6	9.7	0.022	0.012	0.1	0.22	0.6	0.82	0.8	
Cadotte R.	00AL07NB1000	09/05/88	9.9	2.4	268	160	114	30		L.1	0.005	16.6	18.2	0.2	0.018	0.09	L.003	1.14	1.143	10	
		20/06/88	8.9	1.4	351	167	176	60	1.71	0.8	0.006	22	23	0.35	0.027	0.03	0.026	1.76	1.786	6.8	
		21/07/88	8.6	0.3	706	170	272	100	2.58	0.9	0.005	25.8	26.4	0.64	0.045	0.12	0.023	3.36	3.383	3.5	
		22/08/88	8.9	1.4	35	190	24	70	0.7	0.4	L.001	20	20.1	0.072	0.014	0.06	L.003	1.08	1.083	9	
		28/09/88	11.2	0.7	2.4	350	5.6	70	1.1	0.44	L.001	20	20	0.038	0.015	0.03	L.003	0.52	0.523	2.3	
		12/12/88	13.3	6	12.4	310	18	50	1.38	0.36	0.006	21.1	21.5	0.072	0.027	0.12	0.135	0.9	1.035	1.7	
		01/03/89	14.2	1.2	7.41	400	10	40	1.3	0.4	0.003	22.5	23.2	0.081	0.04	0.2	0.33	1.16	1.49	0.4	
PR u/s Notikewin R.-c	00AL07NC1200	10/05/88	10.4	1.5	160	115	136	70		L.1	0.002	6	6.2	0.18	0.009	0.01	0.032	0.62	0.652	1.7	1
		20/06/88	9.6	0.8	192	108	112	30	0.6	0.2	0.002	5.4	6.4	0.186	0.009	0.02	0.028	0.56	0.588	1.4	
		20/06/88		L.1	166	110	110	40	0.6	0.4	0.001	5.6	5.8	0.172	0.008	0.01	0.027	0.48	0.507	1.4	
		20/06/88		0.5	183	110	114	30	0.3	0.3	0.001	5.4	5.6	0.173		0.02	0.02	0.54	0.56	1.4	
		19/07/88	9.2	1.8	504	120	340	80	1.64	0.8	0.002	8.7	8.9	0.46	0.015	0.06	0.089	1.1	1.189	1.1	

Appendix V. Continued.

Station	Code	Date D/M/Y	DO mg/L 08102	BOD mg/L 08202	Susp. Solid mg/L 10401	Filt. Residue mg/L 10451	Turb. NTU 02074	True Color RCU 02021	Tann. & Lig. mg/L 06551	Oil & Grease mg/L 06521	Phenol mg/L 06537	DOC mg/L 06104	TOC mg/L 06005	Total P mg/L 15406	Diss. P mg/L 15103	Total NH3 mg/L 07505	NO2+NO3 mg/L 07110	TKN mg/L 07015	Total N mg/L 07602	Phyto. Chla mg/m3 06715	Epil. Chla mg/m2 06722
PR u/s Notikewin R.-c	00AL07HC1200	22/08/88	9.6	0.3	2.5	110	10	20	0.2	0.4	L.001	3.7	3.7	0.021	0.007	L.01	L.003	0.2	0.203	2.8	15.7
		22/08/88		0.7	19	110	12	20	0.2	0.4	0.001	3.8	3.9	0.022	0.006	L0.01	L.003	0.2	0.203	2.9	
		22/08/88		1	19.5	110	7.2	30	0.2	0.4	L.001	3.6	3.6	0.018	0.006	0.01	L.003	0.32	0.323	3	
		28/09/88	10	0.4	5.6	100	3.2	30	0.4	0.4	L.001	3.3	3.6	0.014	0.003	L.01	0.013	0.2	0.213	2.4	5.7
		13/12/88	13	0.06	0.4	110	2.8	20	0.272	0.96	L.001	2.3	2.3	0.006	0.003	L.01	0.047	0.18	0.227	0.9	
		01/03/89	13	0.8	0.62	110	1.4	20	0.2	0.3	0.001	2.5	2.7	0.007	0.004	0.01	0.045	0.2	0.245	0.4	
Notikewin R.	00AL07HC1400	10/05/88	10.2	1.6	156	100	134	200		L.1	0.009	23	24	0.2	0.029	0.03	0.006	0.9	0.906	1.9	
		20/06/88	8.8	0.9	64	140	46	120	2.3	0.3	0.006	25	25.5	0.074	0.02	0.07	L.003	1.04	1.043	1.8	
		19/07/88	9.3	2.6	722	140	400	150	3.72	3.7	0.005	28.7	28.9	0.66	0.029	0.07	0.009	1.76	1.769	0.6	
		22/08/88	9.1	1	67	160	58	150	1.2	0.4	0.004	23	23.2	0.092	0.019	0.04	L.003	0.88	0.883	5.1	
		28/09/88	11	1.1	2	235	4.2	200	1.6	0.48	L.001	21.6	19.5	0.027	0.013	0.03	L.003	1.34	1.343	0.8	
		13/12/88	12.6	0.2	L.4	350	11	150	1.52	0.88	0.003	20.2	21	0.041	0.018	0.06	0.045	0.68	0.725	0.3	
		01/03/89	11.7	1.6	19	620	20	50	0.9	0.4	0.002	21.9	23	0.051	0.014	0.16	0.27	0.98	1.25	2	
PR nr Carcajou-c	00AL07HD1030	10/05/88	10.5	0.9	167	115	150	40		L.1	0.003	6.6	6.8	0.21	0.009	0.02	0.039	0.64	0.679	1.2	1.1
		21/06/88	9.1	0.7	126	110	118	40	0.77	0.5	0.001	6.6	7.2	0.177	0.01	0.02	0.029	0.58	0.609	1.3	
		19/07/88	8.9	1.6	648	120	388	150	1.7	0.8	0.002	11.2	11.5	0.51	0.015	0.04	0.072	1.2	1.272	1.2	
		23/08/88	9.1	0.1	11	110	20	10	0.12	0.4	L.001	4	4.3	0.015	0.003	0.01	L.003	0.24	0.243	2.4	10.8
		28/09/88	10	0.4	8.4	100	3.6	40	0.39	0.44	L.001	3	3	0.014	0.004	L.01	0.012	0.2	0.212	2.6	52
		13/12/88	13.1	0.77	L.4	120	2.8	30	0.32	1.04	L.001	2.3	2.4	0.006	0.004	0.01	0.042	0.2	0.242	0.7	
		01/03/89	13.7	0.7	L.4	110	2.2	20	0.2	0.3	0.001	2.6	2.8	0.01	0.006	0.01	0.047	0.2	0.247	0.4	
Wolverine R.	00AL07HE1000	10/05/88	10.3	3.1	398	155	310	60		L.1	0.007	20.2	20.8	0.36	0.027	0.05	0.008	1.44	1.448	9.1	
		21/06/88	8.9	1.4	65.2	200	120	100	1.99	0.2	0.005	25	28.5	0.212	0.021	0.07	L.003	1.6	1.603	13.5	
		19/07/88	8.8	2.6	742	180	392	150	3.02	0.96	0.005	29.9	31.2	0.76	0.017	0.17	0.024	2.12	2.144	1.7	
		23/08/88	9.4	3.2	124	180	74	100	1.05	0.2	L.001	25	25	0.177	0.017	0.1	0.14	1.68	1.82	26.4	
		28/09/88	11.3	4.1	43.2	190	24	150	1.52	0.52	L.001	26.1	26.4	0.122	0.016	0.05	L.003	1.56	1.563	64.3	
		13/12/88	12.3	1.26	33.2	260	32	100	1.92	1.04	0.005	26.2	28	0.088	0.024	0.19	0.226	1.28	1.506	2.1	
Keg R.	00AL07HF1300	10/05/88	10.5	0.7	437	185	400	100		L.1	0.008	22.6	24.5	0.36	0.03	0.12	0.027	1.72	1.747	2.5	
		21/06/88	8.9	L.1	104	200	98	100	2.46	0.9	0.006	23.5	25.3	0.124	0.022	0.05	0.026	1.1	1.126	0.8	
		19/07/88	8.7	1.8	224	180	184	150	3.19	0.7	0.005	28.1	28.3	0.275	0.033	0.06	0.014	1.3	1.314	0.7	
		23/08/88	8.9	0.2	19	290	28	100	1.12	0.3	L.001	22	23	0.056	0.01	0.04	L.003	0.84	0.843	2.1	
		28/09/88	10.8	0.7	13.2	330	12	70	1.64	0.44	L.001	18	18.5	0.04	0.028	0.03	L.003	0.7	0.703	1.8	
		13/12/88	12.1	0.75	17.6	390	28	100	1.62	1	0.005	19.3	20	0.068	0.016	0.05	0.037	0.72	0.757	0.2	
		01/03/89	12.8	1.4	L.4	460	14	40	0.9	0.4	0.004	23.5	24	0.047	0.017	0.17	0.216	1.06	1.276	0.1	
PR nr La Crete-c	00AL07HF1530	10/05/88	10.4	1.1	195	120	154	40		L.1	0.003	8	8.2	0.3	0.012	0.02	0.037	0.74	0.777	1.3	
		21/06/88	9.1	0.6	238	110	140	50	0.8	0.8	0.002	7.2	7.5	0.2	0.011	0.04	0.033	0.62	0.653	1.2	
		19/07/88	8.7	1.9	852	140	530	100	1.81	0.6	0.002	11.6	12.4	0.64	0.032	0.06	0.096	1.26	1.356	1.2	
		23/08/88	9	0.4	7.5	110	6.4	20	0.18	0.2	L.001	3.9	4.2	0.016	0.004	L.01	L.003	0.28	0.283	2.7	
		28/09/88	10	0.3	6.4	100	3.6	40	0.31	0.4	L.001	2.8	3.1	0.012	0.004	L.01	0.008	0.22	0.228	2.8	
		13/12/88	12.9	0.3	7.6	120	4.8	20	0.352	1.04	L.001	2.4	2.5	0.012	0.004	0.01	0.041	0.2	0.241	0.7	
		02/03/89	12.7	0.3	4.41	110	1.6	30	0.3	0.2	L.001	2.7	3	L.003	L.003	0.01	0.056	0.2	0.256	0.4	
PR nr Ft. Vermilion-c	00AL07HF1720	11/05/88	10.3	1.4	202	110	86	30		L.1	0.003	7.6	8	0.27	0.01	0.02	0.044	0.62	0.664	1.2	4.4
		21/06/88	8.6	L.1	319	110	210	50	0.93	0.9	0.001	7.8	9	0.37	0.008	0.04	0.038	0.88	0.918	1.3	
		19/07/88	8.1	2.3	1058	140	620	50	1.58	0.8	0.002	11.9	12.2	0.76	0.022	0.05	0.043	1.52	1.563	1.2	
		23/08/88	8.8	0.4	18	110	8	20	0.21	0.3	L.001	3.4	3.8	0.028	0.005	L.01	L.003	0.26	0.263	2.8	3
		29/09/88	10	9.6	25.6	145	38	250	3.12	0.52	L.001	23	23.5	0.071	0.025	0.05	L.003	0.56	0.563	3.8	
		13/12/88	13.1	0.39	1.6	120	3	30	0.32	1	0.001	1.8	2.6	0.006	0.004	L.01	0.046	0.2	0.246	0.6	

Appendix V. Continued.

Station	Code	Date D/M/Y	DO mg/L 08102	BOD mg/L 08202	Susp. Solid mg/L 10401	Filt. Residue mg/L 10451	Turb. NTU 02074	True Color RCU 02021	Tann. & Lig. mg/L 06551	Oil & Grease mg/L 06521	Phenol mg/L 06537	DOC mg/L 06104	TOC mg/L 06005	Total P mg/L 15406	Diss. P mg/L 15103	Total NH3 mg/L 07505	NO2+NO3 mg/L 07110	TKN mg/L 07015	Total N mg/L 07602	Phyto. Chla mg/m3 06715	Epil. Chla mg/m2 06722
PR nr Ft. Vermilion-c	00AL07HF1720	13/12/88		0.3	0.4	130	3	30	0.3	1	0.001	2.1	2.9	0.01	0.003	L.01	0.041	0.16	0.201	0.5	
		13/12/88		0.2	1.2	120	2.8	20	0.4	1	0.001	2.8	2.9	0.008	0.005	L.01	0.041	0.1	0.141	0.5	
		02/03/89	12.9	0.3	5.06	110	2	10	0.3	0.2	L.001	2.8	2.9	L.003	L.003	0.01	0.052	0.24	0.292	0.6	
		02/03/89		0.5	1.94	110	2	20	0.2	0.3	L.001	2.7	2.7	L.003	L.003	0.01	0.054	0.16	0.214	0.6	
		02/03/89		0.3	5.43	110	1.8	20	0.2	0.3	L.001	2.6	3.1	L.003	L.003	0.01	0.055	0.2	0.255	0.6	
Ft. Vermilion STP	21AL07HF1000	24/05/88		11.5	27	295	6.5	30		L.1	0.014	11.8	12.2	3.2	2.6	13	0.029	15.2	15.23		
Boyer R.	00AL07JF1000	10/05/88	10.6	6.7	2314	160	1540	100		L.1	0.01	25.5	26.5	1.34	0.038	0.08	0.029	4.8	4.829		
		21/06/88	8.5	0.5	499	190	188	160	3.02	0.3	0.005	24.8	25.8	0.36	0.04	0.17	0.035	1.36	1.395	4.7	
		19/07/88	8.2	1.3	268	240	190	150	3.62	0.2	0.007	26.6	28	0.33	0.058	0.07	0.11	1.5	1.61	2.6	
		23/08/88	9	0.9	648	225	620	200	2.68	0.4	L.001	19	19	0.7	0.025	0.11	0.04	1.8	1.84	3.4	
		29/09/88	10.5	0.2	11.6	100	4.2	40	0.39	0.4	L.001	3.5	3.8	0.02	0.004	L.01	L.003	0.22	0.223	1.2	
		13/12/88	10.6	0.25	4.4	390	16	150	2.82	0.92	0.006	26.2	28.3	0.066	0.03	0.06	0.121	0.86	0.981	0.2	
		02/03/89	10	1.1	1.2	800	9.2	60	1.8	0.4	0.003	27	27.3	0.038	0.005	0.08	0.34	1.16	1.5	0.1	
Wabasca R.	00AL07JD1000	11/05/88	10	2.9	333	125	260	100		L.1	0.006	20.5	21	0.3	0.029	0.02	0.005	1.18	1.185	5.5	
		21/06/88	8.4	1.1	212	120	102	100	2.42	0.3	0.005	23.2	24.3	0.2	0.034	0.08	0.026	1.32	1.346	8.9	
		19/07/88	7.5	2.9	814	180	470	150	3.26	0.7	0.007	28.5	29.8	0.74	0.038	0.08	0.053	2.12	2.173	2.2	
		23/08/88	8.8	2.9	85	150	50	70	0.92	0.3	L.001	22	23	0.147	0.015	0.04	L.003	1.24	1.243	27.2	
		29/09/88	10.5	1.1	42.4	160	58	70	1.19	0.64	L.001	21.1	21.4	0.074	0.012	0.04	L.003	0.88	0.883	17.3	
		14/12/88	8.2	0.66	1.2	230	6.2	70	1.38	0.33	0.003	21.3	21.9	0.04	0.021	0.09	0.222	0.76	0.982	0.4	
		02/03/89	5	0.6	4.38	310	5.2	60	1.5	0.4	0.001	22	22.2	0.047	0.011	0.04	0.46	0.96	1.42	0.2	
Mikkwa River	00AL07JE1000	19/07/88	8.1	2.1	126	120	71	200	4.8	1	0.008	29.2	32.5	0.18	0.045	0.14	L.003	1.18	1.183	0.5	
		23/08/88	9	0.6	10	150	10	100	3.3	0.4	L.001	32	32	0.092	0.055	0.05	L.003	0.9	0.903	5.8	
		14/12/88	9.2	0.6	1.2	180	6	200	2.91	0.33	0.006	26.2	27.4	0.066	0.045	0.03	0.115	0.7	0.815	0.2	
		02/03/89	11.5	1.1	1.7	290	3.8	80	2.1	1.5	0.001	20.4	20.9	0.06	0.027	0.03	0.34	0.74	1.08	0.2	
Wentzel R.-mouth	00AL07KA1500	11/05/88	11.8	3.3	29.2	80	138	200		L.1	0.011	28.4	28.8	0.058	0.03	0.04	0.015	1.24	1.255	2	
Wentzel R.-Hwy.58	00AL07KA1000	21/06/88	10	0.8	35	70	15	80	2.64	0.2	0.005	21.2	22.5	0.05	0.012	0.04	0.008	0.72	0.728	0.9	
		19/07/88	9.1	0.9	44	90	20	100	2.71	0.7	0.006	21.8	22.2	0.054	0.013	0.03	0.011	0.7	0.711	2.1	
Wentzel R.-mouth	00AL07KA1500	23/08/88	9.6	1	29.6	30	58	300	2.7	0.4	L.001	28.1	28.5	0.1	0.016	0.04	L.003	1.02	1.023	2.7	
		29/09/88	11.5	0.8	2.8	124	5.8	200	2.18	1.16	L.001	24.6	24.6	0.079	0.01	0.03	L.003	0.7	0.703	1.7	
		14/12/88	11.8	0.46	0.8	200	5	200	1.94	0.48	0.004	19.6	19.7	0.02	0.012	0.05	0.105	0.62	0.725	0.3	
		02/03/89	8.9	1.3	5.06	490	8.6	60	1.5	0.2	L.001	20	20	0.02	L.003	0.15	0.16	0.8	0.96	0.1	
PR u/s Wood Buffalo-c	00AL07KA2000	11/05/88	10.9	1.7	408	120	370	40		L.1	0.004	9	9.4	0.37	0.019	0.02	0.045	1.04	1.085	1.6	
		21/06/88	8.8	L.1	580	110	348	80	1.21	0.5	0.001	10	10.5	0.48	0.012	0.11	0.044	1.14	1.184	1.9	
		19/07/88	7.9	2.7	1058	160	660	150	3.34	0.7	0.004	24	24.9	0.76	0.031	0.07	0.042	1.88	1.922	1.4	
		23/08/88	9	0.5	17.5	120	18	40	0.4	0.5	L.001	6.7	6.8	0.048	0.006	0.02	L.003	0.36	0.363	4.8	
		29/09/88	10.4	0.7	40.8	110	22	50	0.58	0.36	L.001	5.3	5.5	0.077	0.005	L.01	L.003	0.34	0.343	5.4	
		14/12/88	12.4	0.32	1.6	120	3.2	30	0.384	0.48	L.001	3.9	4	0.008	0.004	0.01	0.056	0.18	0.236	0.5	
		02/03/89	13	0.3	5.71	110	2.2	20	0.4	0.2	L.001	2.8	2.8	0.003	L.003	0.01	0.06	0.22	0.28	0.5	
PR nr Peace Point-c	00AL07KC1000	11/05/88	10.3	2.6		110	375	40		L.1	0.004	10	10.2	0.39	0.027	0.03	0.049	1.02	1.069	1.8	
		21/06/88	8.4	0.8	1500	120	970	100	1.77	2	0.002	12.4	13	1.04	0.014	0.1	0.066	2.2	2.266	2	
		19/07/88	7.9	2	664	140	410	50	1.71	1.2	0.002	14.3	15.5	0.595	0.016	0.2	0.045	1.5	1.545	1.4	
		23/08/88	9.1	0.7	28.8	120	14	30	0.3	0.5	L.001	5.9	6.1	0.05	0.006	0.01	L.003	0.34	0.343	4	
		29/09/88	10.3	0.8	28.8	110	19	50	0.93	0.44	L.001	5.4	6.2	0.036	0.005	L.01	L.003	0.32	0.323	5.5	
		14/12/88	12.7	0.1	220	120	84	30	0.384	0.58	L.001	3.1	3.8	0.133	0.01	0.01	0.053	0.32	0.373	6.7	
		02/03/89	12.5	0.3	5.21	110	2.4	20	0.2	0.2	L.001	2.9	3.1	L.003	L.003	0.01	0.059	0.22	0.279	0.4	

Appendix V. Continued.

Station	Code	Date D/M/Y	Total Colif. #/100mL 36001	Fecal Colif. #/100mL 36011	Std.Pl. Count #/mL 36905	CN mg/L 06608	Total Al mg/L 13003	Diss. Al mg/L 13106	Total As mg/L 33005	Diss. As mg/L 33104	Total Ba mg/L 56001	Diss. Ba mg/L 56101	Total Be mg/L 04002	Diss. Be mg/L 04111	Total B µg/L 05003	Diss. B mg/L 05107	Total Cd mg/L 48002	Diss. Cd mg/L 48102	Total Cr mg/L 24004	Diss. Cr mg/L 24052
PR nr border-c	008C07FD1050	09/05/88	28	12	1300	L.001	1.75	0.03	0.004	0.0002	0.17	0.08	L.001	L.001	0.05	0.01	L.001	L.001	L.001	L.001
		20/06/88	23	23	720	L.001	0.42	0.05	0.0006	0.0003	0.06	0.05	L.001	L.001	0.02	0.01	L.001	L.001	L.001	L.001
		21/07/88	170	8	4400	0.001	0.6	0.01	0.0011	0.0003	0.06	0.06	L.001	L.001	0.01	L.01	L.001	L.001	L.001	L.001
		22/08/88	8	8	2000	L.001	0.09	0.02	0.0003	L.0002	0.04	0.04	L.001	L.001	0.02	0.02	L.001	L.001	L.001	L.001
		03/10/88	30	4	1000	0.001	0.13	0.01	0.0003	L.0002	0.08	0.04	L.001	L.001	0.04	0.01	L.001	L.001	L.001	L.001
		12/12/88	27	17	90	L.001	0.03	0.02	0.0005	0.0003	0.04	0.04	L.001	L.001	]	L.01	L.001	L.001	L.001	L.001
		28/02/89	30	4	50	L.001	0.06	L.01	0.0003	0.0003	0.04	0.04	L.001	L.001	L.01	L.01	0.001	L.001	L.001	L.001
Pouce Coupe R.	00AL07FD0500	09/05/88	50	4	1300	L.001	0.43	0.02	0.0037	0.0009	0.09	0.04	L.001	L.001	0.08	0.05	L.001	L.001	L.001	L.001
		20/06/88	130	22	19000	0.001	2.2	0.02	0.0028	0.0008	0.1	0.06	0.001	L.001	0.06	0.05	0.001	L.001	0.007	L.001
		21/07/88	900	50	5700	0.001	0.64	0.01	0.0021	0.0012	0.07	0.06	L.001	L.001	0.05	0.04	L.001	L.001	L.001	L.001
		22/08/88	50	50	840	0.001	0.14	0.01	0.0006	0.0003	0.08	0.07	L.001	L.001	0.1	0.09	L.001	L.001	L.001	L.001
		27/09/88	30	30	310	0.001	0.08	0.01	0.0004	0.0004	0.08	0.08	L.001	L.001	0.13	0.12	L.001	L.001	0.011	0.002
		12/12/88	11	4	140	L.001	0.11	L.01	0.0006	0.0003	0.09	0.08	L.001	L.001	0.02	L.01	L.001	L.001	L.001	L.001
		28/02/89	4	4	210	0.001	0.22	L.01	0.002	0.0005	0.11	0.09	L.001	L.001	0.25	0.13	L.001	L.001	0.001	L.001
PR nr Dunvegan-cmp	00AL07FD1600	09/05/88	30	20	2600	L.001	0.71	0.01	0.012	0.0004	0.3	0.05	0.002	L.001	0.12	0.03	L.001	L.001	0.02	L.001
		20/06/88	14	14	1500	L.001	0.75	0.01	0.0009	0.0002	0.07	0.06	L.001	L.001	0.02	0.03	L.001	L.001	0.002	L.001
		21/07/88	300	13	14000	0.001	1.06	0.02	0.0018	0.0003	0.09	0.06	L.001	L.001	0.02	L.01	L.001	L.001	0.006	L.001
		22/08/88	17	13	220	L.001	0.13	0.02	0.0003	0.0002	0.04	0.04	L.001	L.001	0.01	L.01	L.001	L.001	L.001	L.001
		27/09/88	4	4	270	0.001	0.07	0.02	0.0003	L.0002	0.04	0.03	L.001	L.001	0.02	0.01	L.001	L.001	L.001	L.001
		12/12/88	90	21	280	L.001	0.03	0.02	0.0002	0.0002	0.04	0.04	L.001	L.001	L.01	L.01	L.001	L.001	L.001	L.001
PR nr Dunvegan-c	00AL07FD1525	28/02/89	8	2	10	L.001	0.04	L.01	0.0004	0.0003	0.04	0.04	L.001	L.001	L.01	L.01	L.001	L.001	L.001	L.001
PR u/s Smoky R.-cmp	00AL07FD4600	09/05/88	60	L4.	710	L.001	0.95	0.01	0.0026	0.0003	0.12	0.06	L.001	L.001	0.06	0.01	L.001	L.001	0.002	L.001
		09/05/88	60	L4.	490	L.001	2	0.02	0.0029	0.0002	0.13	0.06	L.001	L.001	0.11	0.02	L.001	L.001	0.007	L.001
		09/05/88	60	L4.	2200	L.001	1.48	0.03	0.0029	0.0004	0.12	0.06	L.001	L.001	0.17	0.01	L.001	L.001	0.022	0.003
		20/06/88	30	8	3800	L.001	1.16	0.02	0.0016	0.0002	0.09	0.06	L.001	L.001	0.02	0.02	L.001	L.001	0.005	L.001
		21/07/88	240	50	64000	0.001	0.65	0.02	0.01	0.0006	0.3	0.1	L.001	L.001	0.01	0.01	L.001	L.001	L.001	L.001
		22/08/88	11	7	210	L.001	0.11	0.01	0.0003	0.0002	0.04	0.04	L.001	L.001	0.02	0.02	L.001	L.001	L.001	L.001
		28/09/88	34	34	150	0.001	0.05	0.04	0.0003	0.0002	0.04	0.04	L.001	L.001	0.05	L.01	L.001	L.001	L.001	L.001
		12/12/88	30	4	350	L.001	0.04	0.02	0.0003	0.0002	0.04	0.04	L.001	L.001	L.01	L.01	L.001	L.001	0.001	L.001
PR u/s Smoky R.-c	00AL07FD4575	28/02/89	8	0	70	0.001	1.2	L.01	0.0037	0.0003	0.08	0.04	L.001	L.001	L.01	L.01	L.001	L.001	0.002	L.001
P.R.Corr.Inst. STP	21AL07FD1000	09/05/88	L4.	L4.	50	0.002	0.07	0.06	0.0003	0.0003	0.02	0.02	L.001	L.001	0.04	0.03	L.001	L.001	L.001	L.001
		20/06/88	17	11	420000	0.006	0.1		0.0003		0.03		L.001		0.04		0.001		0.001	
		21/07/88	0	0	800	0.008	0.19		0.0005		0.04		L.001		0.1		L.001		L.001	
		29/08/88	0	0	L10.	0.005	0.04		L.0002		0.04		L.001		0.11		L.001		0.001	
		28/09/88	0	0	L10.	0.004	0.01		0.0005		0.04		L.001		0.09		L.001		L.001	
		14/12/88	0	0	L10.	0.004	0.06		0.0011		0.03		L.001		0.02		L.001		0.003	
		01/03/89	0	0	L10.	0.004	0.15		0.0008		0.02		L.001		0.08		L.001		0.001	
Smoky R.	00AL07GJ4995	09/05/88	12	4	40000	L.001	0.88	0.02	0.001	0.0003	0.1	0.08	L.001	L.001	0.07	0.02	L.001	L.001	L.001	L.001
		20/06/88	300	8	17000	L.001	3.5	0.01	0.0049	0.0004	0.16	0.09	L.001	L.001	0.05	0.02	L.001	L.001	0.006	L.001
		21/07/88	240	8	13000	0.001	1.58	0.02	0.0022	0.0007	0.12	0.12	L.001	L.001	0.03	L.01	L.001	L.001	0.007	L.001
		22/08/88	13	8	8100	L.001	0.34	0.01	0.0006	0.0002	0.08	0.07	L.001	L.001	0.02	0.01	L.001	L.001	L.001	L.001
		27/09/88	4	4	5200	0.001	0.12	0.02	0.0005	0.0002	0.09	0.09	L.001	L.001	0.02	0.02	L.001	L.001	L.001	L.001
		12/12/88	4	4	4200	L.001	0.04	0.02	0.0003	0.0003	0.12	0.12	L.001	L.001	L.01	L.01	L.001	L.001	L.001	L.001
		01/03/89	0	0	120000	0.001	0.06	0.03	0.0009	0.0007	0.13	0.13	L.001	L.001	0.08	0.08	L.001	L.001	0.004	0.003
Grande Prairie STP	21AL07GE1000	09/05/88	4000	250	27000	0.002	0.04	L.01	0.0011	0.0011	0.04	0.03	L.001	L.001	0.33	0.26	L.001	L.001	L.001	L.001
		20/06/88	1300	140	30000	0.002	0.2	0.13	0.0026	0.0022	0.05	0.05	L.001	L.001	0.26	0.26	L.001	L.001	L.001	L.001

Appendix V. Continued.

Station	Code	Date D/M/Y	Total Colif. #/100mL 36001	Fecal Colif. #/100mL 36011	Std.Pl. Count #/mL 36905	CN mg/L 06608	Total Al mg/L 13003	Diss. Al mg/L 13106	Total As mg/L 33005	Diss. As mg/L 33104	Total Ba mg/L 56001	Diss. Ba mg/L 56101	Total Be mg/L 04002	Diss. Be mg/L 04111	Total B mg/L 05003	Diss. B mg/L 05107	Total Cd mg/L 48002	Diss. Cd mg/L 48102	Total Cr mg/L 24004	Diss. Cr mg/L 24052
Grande Prairie STP	21AL07GE1000	13/07/88	3000	170	39000	0.003	0.04	0.04	0.0024	0.0024	0.04	0.03	L.001	L.001	0.25	0.24	0.015	0.012	L.001	L.001
		04/01/89	110000	13000	190000	0.004	0.06		0.001		0.03		L.001		0.23		L.001		L.001	
		02/03/89	16400	4700					0.0016		0.037		L.001		0.244		0.002		0.006	
P&G Effluent-grab	20AL07GE8000	11/05/88	650	L10.	3.0E+06	0.002	4.3	1.8	0.0014	0.0005	0.47	0.43	L.001	L.001	0.1	0.06	0.004	L.001	0.009	0.009
		20/06/88	240	4	7.7E+06	0.002	1.23	1.15	0.0014	0.0014	0.38	0.37	0.002	L.001	0.04	0.04	0.005	0.003	0.037	0.036
		13/07/88	50000	130	1.0E+07	0.002	0.8	0.2	0.0002	0.0002	0.46	0.1	L.001	L.001	0.06	0.03	0.017	0.017	0.01	L.001
		22/08/88	1700	12	5.3E+06	0.002	0.42		0.0009		0.52		L.001		0.04		0.002		0.003	
		19/09/88	2400	50	4.1E+06	0.001	0.68		0.0017		0.24		L.001		0.03		0.004		L.0010	
		15/12/88	110	7	1.6E+06	0.003	0.8		0.0017		0.45		L.001		0.01		0.002		0.009	
P&G Effluent-cmp	20AL07GE8001	02/03/89	1300	400			0.15		0.001		0.167		L.001				0.005		0.131	
Peace River STP	21AL07HA1000	10/05/88	7.4E+05	2.4E+04	6.2E+05	0.006	0.09	0.09	0.0016	0.001	0.05	0.02	L.001	L.001	0.24	0.21	L.001	L.001	L.001	L.001
		20/06/88	7.0E+05	5.0E+05	2.1E+06	0.005	0.16		0.0012		0.07		L.001		0.23		L.001		0.005	
		21/07/88	3.0E+05	1.7E+05	1.5E+06	0.006	0.19		0.002		0.08		L.001		0.27		L.001		0.008	
		22/08/88	1.7E+06	5.0E+05	9.9E+05	0.004	0.16		0.0015		0.05		L.001		0.23		L.001		L.001	
		27/09/88	1.6E+07	1.6E+06	1.5E+06	0.004	0.2		0.002		0.05		L.001		0.26		L.001		0.003	
		12/12/88	5.0E+06	1.7E+06	1.7E+06	0.004	0.14		0.0011		0.05		L.001		0.15		L.001		L.001	
		01/03/89	1.7E+06	5.0E+05	1.4E+06	0.003	0.12		0.0021		0.06		L.001		0.18		L.001		0.001	
Peace River Oils	00AL07HA2400	17/05/88				0.003	0.03		L.0002		32		0.005		13		L.001		L.001	
		04/10/88				0.001	0.02		0.0005		29		L.001		13.2		L.001		L.001	
		01/03/89				0.002	0.02		0.0012		40		L.001		12		L.001		L.001	
PR u/s Whitemud R.-cmp	00AL07HA2850	10/05/88	60	8	1600	L.001	1.64	0.01	0.0029	0.0004	0.13	0.09	L.001	L.001	0.13	0.06	L.001	L.001	0.013	L.001
		20/06/88	80	9	9900	L.001	1.75	0.03	0.0023	0.0004	0.1	0.08	L.001	L.001	0.03	0.02	L.001	L.001	0.006	0.005
		21/07/88	300	27	16000	0.002	1.61	0.02	0.0029	0.0004	0.12	0.08	L.001	L.001	0.01	L.01	0.001	L.001	0.009	0.002
		22/08/88	30	2	760	0.001	0.1	0.01	0.0003	0.0002	0.05	0.05	L.001	L.001	L.01	L.01	L.001	L.001	L.001	L.001
		28/09/88	240	50	470	0.001	0.09	0.03	0.0003	L.0002	0.04	0.04	L.001	L.001	0.02	0.01	L.001	L.001	0.005	L.001
		12/12/88	240	30	770	L.001	0.03	0.01	0.0002	0.0002	0.04	0.04	L.001	L.001	0.02	L.01	L.001	L.001	L.001	L.001
PR u/s Whitemud R.-c	00AL07HA2820	01/03/89	80	70	640	L.001	0.03	0.02	0.0006	0.0006	0.05	0.05	L.001	L.001	0.04	0.04	L.001	L.001	L.001	L.001
Whitemud R.	00AL07HA3000	09/05/88	40	10	880	L.001	2	0.03	0.0067	0.0006	0.17	0.04	L.001	L.001	0.13	0.04	L.001	L.001	0.011	L.001
		20/06/88	500	4	9300	0.001	7.3	0.02	0.011	0.0008	0.22	0.06	0.002	L.001	0.11	0.05	L.001	L.001	0.007	L.001
		21/07/88	500	50	6700	0.001	5.1	0.03	0.019	0.0014	0.12	0.16	0.001	L.001	0.03	0.05	L.001	L.001	0.002	L.001
		22/08/88	300	34	8100	0.001	1.5	0.03	0.004	0.0006	0.1	0.05	L.001	L.001	0.06	0.04	L.001	L.001	L.001	L.001
		28/09/88	2	2	40	0.001	0.21	0.08	0.0011	0.0006	0.05	0.04	L.001	L.001	0.05	0.05	L.001	L.001	0.005	L.001
		12/12/88	13	0	130	L.001	0.17	0.03	0.001	0.0003	0.06	0.06	L.001	L.001	L.01	0.01	L.001	L.001	L.001	L.001
		01/03/89	27	8	300	L.001	0.15	0.01	0.0027	0.0005	0.07	0.06	L.001	L.001	0.14	0.14	L.001	L.001	0.003	L.001
Cadotte R.	00AL07HB1000	09/05/88	28	4	520	L.001	3.1	0.01	0.0036	0.0005	0.12	0.05	L.001	L.001	0.15	0.04	L.001	L.001	L.001	L.001
		20/06/88	500	17	10000	0.001	10.7	L.01	0.0053	0.0008	0.16	0.05	0.001	L.001	0.08	0.03	L.001	L.001	0.002	0.001
		21/07/88	900	50	11000	0.002	2.2	0.01	0.013	0.001	0.25	0.16	L.001	L.001	0.02	0.02	L.001	L.001	L.001	L.001
		22/08/88	30	17	4100	0.002	0.26	0.02	0.001	0.0007	0.06	0.06	L.001	L.001	0.04	0.04	L.001	L.001	L.001	L.001
		28/09/88	17	17	1200	0.001	0.05	0.02	0.001	0.0008	0.06	0.06	L.001	L.001	0.12	0.12	L.001	L.001	0.004	L.001
		12/12/88	8	4	200	L.001	0.14	0.01	0.0007	0.0006	0.06	0.06	L.001	L.001	0.04	0.03	L.001	L.001	L.001	L.001
		01/03/89	50	4	130	0.001	0.12	0.02	0.0025	0.0013	0.08	0.08	L.001	L.001	0.16	0.16	L.001	L.001	0.002	0.001
PR u/s Notikewin R.-c	00AL07HC1200	10/05/88	100	12	850	L.001	11.1	0.01	0.0034	0.0011	0.15	0.07	L.001	L.001	0.08	0.02	L.001	L.001	0.009	L.001
		20/06/88	80	11	5100	L.001	2	0.01	0.0029	0.0004	0.12	0.08	L.001	L.001	0.01	0.03	L.001	L.001	0.009	L.001
		20/06/88	80	30	11000	L.001	2	0.02	0.0026	0.0004	0.12	0.07	L.001	L.001	0.01	0.01	L.001	L.001	0.004	L.001
		20/06/88	70	8	4000	L.001	2.7	0.03	0.0022	0.0004	0.12	0.07	0.001	L.001	0.05	0.01	L.001	L.001	0.006	L.001
		19/07/88	900	17	65000	0.002	6.6	0.03	0.019	0.0006	0.28	0.07	0.001	L.001	0.02	0.02	0.004	L.001	0.002	L.001

Appendix V. Continued.

Station	Code	Date D/M/Y	Total Colif. #/100mL 36001	Fecal Colif. #/100mL 36011	Std.Pl. Count #/mL 36905	CN mg/L 06608	Total Al mg/L 13003	Diss. Al mg/L 13106	Total As mg/L 33005	Diss. As mg/L 33104	Total Ba mg/L 56001	Diss. Ba mg/L 56101	Total Be mg/L 04002	Diss. Be mg/L 04111	Total B mg/L 05003	Diss. B mg/L 05107	Total Cd mg/L 48002	Diss. Cd mg/L 48102	Total Cr mg/L 24004	Diss. Cr mg/L 24052
PR u/s Notikewin R.-c	00AL07HC1200	22/08/88	23	2	810	L.001	0.19	0.06	0.0004	0.0002	0.05	0.05	L.001	L.001	0.02	L.01	L.001	L.001	L.001	L.001
		22/08/88	23	8	790	0.001	0.19	0.02	0.0004	0.0002	0.05	0.05	L.001	L.001	0.02	L.01	L.001	L.001	L.001	L.001
		22/08/88	50	11	850	0.001	0.19	0.02	0.0003	0.0002	0.05	0.05	L.001	L.001	L.01	L.01	L.001	L.001	L.001	L.001
		28/09/88	50	30	170	0.001	0.09	0.01	0.0003	0.0002	0.04	0.04	L.001	L.001	L.01	L.01	L.001	L.001	0.002	0.002
		13/12/88	300	50	640	L.001	0.08	L.01	0.0005	0.0003	0.04	0.04	L.001	L.001	L.01	L.01	L.001	L.001	L.001	L.001
		01/03/89	30	13	580	L.001	0.02	0.01	0.0007	0.0005	0.05	0.05	L.001	L.001	0.03	0.03	L.001	L.001	0.002	L.001
Notikewin R.	00AL07HC1400	10/05/88	52	16	180	L.001	1.2	0.04	0.0042	0.001	0.11	0.04	L.001	L.001	0.13	0.04	L.001	L.001	0.009	L.001
		20/06/88	130	11	2200	0.001	0.81	0.02	0.0017	0.0006	0.06	0.05	L.001	L.001	0.06	0.03	L.001	0.003	0.02	0.001
		19/07/88	5000	170	5700	0.001	10.3	0.04	0.015	0.0009	0.33	0.06	0.001	L.001	0.09	0.03	0.004	L.001	0.019	L.001
		22/08/88	900	300	7000	0.001	0.8	0.02	0.0025	0.0007	0.08	0.05	L.001	L.001	0.06	0.04	L.001	L.001	0.005	0.003
		28/09/88	170	110	150	0.001	0.05	0.02	0.001	0.0005	0.05	0.05	L.001	L.001	0.06	0.06	L.001	L.001	L.001	L.001
		13/12/88	7	4	40	L.001	0.12	0.02	0.0018	0.0007	0.07	0.07	L.001	L.001	0.04	0.04	L.001	L.001	L.001	L.001
		01/03/89	4	0	180	0.001	0.43	0.02	0.0038	0.0009	0.13	0.1	L.001	L.001	0.18	0.18	L.001	L.001	L.001	L.001
PR nr Carcajou-c	00AL07HD1030	10/05/88	60	L4.	1000	L.001	1.12	L.01	0.0036	0.0004	0.13	0.06	L.001	L.001	0.06	0.03	L.001	L.001	0.002	L.001
		21/06/88	110	50	2000	L.001	0.11	0.02	0.0032	0.003	0.11	0.05	L.001	L.001	L.01	L.01	L.001	L.001	0.002	L.001
		19/07/88	700	50	63000	0.001	9	0.02	0.012	0.0005	0.3	0.09	L.001	L.001	0.08	0.01	0.003	L.001	0.019	L.001
		23/08/88	50	17	480	L.001	0.1	L.01	0.0005	0.0006	0.05	0.05	L.001	L.001	0.02	L.01	L.001	L.001	L.001	L.001
		28/09/88	13	0	150	0.001	0.11	0.02	0.0004	0.0002	0.04	0.04	L.001	L.001	0.01	L.01	L.001	L.001	L.001	L.001
		13/12/88	300	50	390	L.001	0.06	L.01	0.0005	0.0003	0.04	0.04	L.001	L.001	0.01	L.01	L.001	L.001	L.001	L.001
		01/03/89	130	17	530	L.001	0.08	L.01	0.0008	0.0006	0.05	0.05	L.001	L.001	0.03	0.03	L.001	L.001	0.002	L.001
Wolverine R.	00AL07HE1000	10/05/88	60	L4.	350	L.001	17.2	0.01	0.0075	0.0005	0.17	0.04	0.001	L.001	0.09	0.03	L.001	L.001	0.01	L.001
		21/06/88	300	70	5300	0.001	1.9	0.02	0.0039	0.0008	0.1	0.07	0.001	L.001	0.05	0.03	L.001	0.001	0.003	L.001
		19/07/88	1600	80	6300	0.002	12.6	0.03	0.013	0.001	0.31	0.07	0.001	L.001	0.07	0.03	0.003	L.001	0.011	L.001
		23/08/88	500	140	6600	0.001	0.66	L.01	0.0028	0.0007	0.08	0.06	L.001	L.001	0.08	0.03	L.001	L.001	L.001	L.001
		28/09/88	50	23	330	0.002	0.36	0.04	0.0014	0.0004	0.05	0.05	L.001	L.001	0.06	0.04	L.001	L.001	0.004	0.003
		13/12/88	21	0	220	L.001	0.4	L.01	0.0016	0.0006	0.07	0.06	L.001	L.001	0.02	L.01	L.001	L.001	L.001	L.001
Keg R.	00AL07HF1300	10/05/88	90	10	810	0.001	2	0.03	0.0084	0.0008	0.17	0.04	0.001	L.001	0.1	0.07	L.001	L.001	0.005	L.001
		21/06/88	30	30	14000	L.001	1.12	0.02	0.0029	0.0007	0.08	0.08	L.001	L.001	0.09	0.07	L.001	0.001	L.001	L.001
		19/07/88	1100	23	7800	0.002	5.5	0.01	0.006	0.0007	0.14	0.07	L.001	L.001	0.09	0.05	0.002	L.001	L.001	L.001
		23/08/88	80	30	1100	0.001	0.3	L.01	0.0019	0.0002	0.07	0.09	L.001	L.001	0.11	0.1	L.001	L.001	L.001	L.001
		28/09/88	7	7	240	0.002	0.23	0.03	0.0011	0.001	0.07	0.06	L.001	L.001	0.1	0.06	L.001	L.001	0.002	0.002
		13/12/88	8	0	80	0.001	0.12	L.01	0.0015	0.0006	0.07	0.07	L.001	L.001	0.06	0.03	L.001	L.001	L.001	L.001
		01/03/89	30	4	150	0.001	0.2	L.01	0.0026	0.0009	0.09	0.08	L.001	L.001	0.1	0.1	L.001	L.001	L.001	L.001
PR nr La Crete-c	00AL07HF1530	10/05/88	60	L4.	590	L.001	1.38	0.01	0.0015	0.0003	0.14	0.06	0.001	L.001	0.06	0.02	L.001	L.001	L.001	L.001
		21/06/88	50	14	7800	L.001	2.3	0.02	0.0039	0.0004	0.14	0.09	L.001	L.001	0.02	0.01	L.001	L.001	0.002	L.001
		19/07/88	1100	130	45000	0.002	13.4	0.03	0.014	0.0006	0.37	0.11	0.001	L.001	0.05	0.01	0.001	L.001	0.027	0.002
		23/08/88	30	23	780	0.001	0.1	L.01	0.0004	L.0002	0.06	0.06	L.001	L.001	0.02	0.02	L.001	L.001	L.001	L.001
		28/09/88	7	7	90	0.001	0.12	0.04	0.0004	L.0002	0.04	0.04	L.001	L.001	0.03	0.02	L.001	L.001	L.001	L.001
		13/12/88	80	50	310	L.001	0.1	L.01	0.0005	0.0003	0.05	0.05	L.001	L.001	L.01	L.01	L.001	L.001	L.001	L.001
		02/03/89	70	11	330	L.001	0.05	0.02	0.0003	L.0002	0.04	0.04	L.001	L.001	0.08	0.07	L.001	L.001	0.002	L.001
PR nr Ft. Vermilion-c	00AL07HF1720	11/05/88	170	12	3800	L.001	3.6	0.01	0.0021	0.0005	0.16	0.09	L.001	L.001	0.1	0.08	L.001	L.001	0.006	L.001
		21/06/88	30	8	71000	L.001	12.3	0.02	0.0053	0.0004	0.18	0.07	0.002	L.001	0.02	L.01	L.001	0.001	0.01	L.001
		19/07/88	1100	280	32000	0.001	25.3	0.02	0.014	0.0006	0.41	0.08	0.001	L.001	0.06	0.01	0.001	L.001	0.017	L.001
		23/08/88	2	2	3000	0.001	0.21	L.01	0.0005	L.0002	0.05	0.05	L.001	L.001	0.02	0.01	L.001	L.001	L.001	L.001
		29/09/88	4	2	250	0.002	0.52	0.06	0.0017	0.0007	0.05	0.04	L.001	L.001	0.08	0.01	L.001	L.001	L.001	L.001
		13/12/88	80	30	90	L.001	0.08	0.02	0.0006	0.0003	0.05	0.05	L.001	L.001	L.01	0.01	L.001	L.001	L.001	L.001

Appendix V. Continued.

Station	Code	Date D/M/Y	Total Colif. #/100mL 36001	Fecal Colif. #/100mL 36011	Std.Pl. Count #/mL 36905	CN mg/L 06608	Total Al mg/L 13003	Diss. Al mg/L 13106	Total As mg/L 33005	Diss. As mg/L 33104	Total Ba mg/L 56001	Diss. Ba mg/L 56101	Total Be mg/L 04002	Diss. Be mg/L 04111	Total B mg/L 05003	Diss. B mg/L 05107	Total Cd mg/L 48002	Diss. Cd mg/L 48102	Total Cr mg/L 24004	Diss. Cr mg/L 24052
PR nr Ft. Vermilion-c	00AL07HF1720	13/12/88	130	34	280	L.001	0.08	0.03	0.0005	0.0003	0.05	0.05	L.001	L.001	0.06	L.01	L.001	L.001	L.001	L.001
		13/12/88	30	17	250	L.001	0.06	0.02	0.0005	0.0002	0.05	0.05	L.001	L.001	0.07	L.01	L.001	L.001	L.001	L.001
		02/03/89	50	13	180	L.001	0.07	0.03	0.0003	0.0003	0.04	0.04	L.001	L.001	0.07	0.07	L.001	L.001	L.001	L.001
		02/03/89	50	2	280	L.001	0.04	0.03	0.0005	0.0002	0.04	0.04	L.001	L.001	0.06	0.06	L.001	L.001	L.001	L.001
		02/03/89	50	13	180	L.001	0.04	L.01	0.0005	0.0003	0.05	0.04	L.001	L.001	0.07	0.07	L.001	L.001	0.001	0.001
Ft. Vermilion STP	21AL07HF1000	24/05/88	1200	70	80000	0.002	0.04	L.01	0.0023	0.0022	0.04	0.02	L.001	L.001	0.26	0.02	L.001	L.001	L.001	L.001
Boyer R.	00AL07JF1000	10/05/88	800	L100.	660	L.001	49	0.04	0.045	0.0015	1.2	0.05	0.005	L.001	0.27	0.05	0.002	L.001	0.055	0.002
		21/06/88	170	80	24000	0.001	2.5	0.03	0.0063	0.001	0.14	0.06	0.001	L.001	0.04	0.02	L.001	0.001	L.001	L.001
		19/07/88	900	80	52000	0.002	7.9	0.03	0.006	0.0013	0.15	0.09	L.001	L.001	0.05	0.01	L.001	L.001	L.001	L.001
		23/08/88	240	80	9600	0.001	0.1	L.01	0.014	0.0004	0.41	0.07	L.001	L.001	0.11	0.04	L.001	L.001	0.016	L.001
		29/09/88	30	8	540	0.001	0.13	0.02	0.0005	0.0002	0.04	0.04	L.001	L.001	0.05	0.02	L.001	L.001	0.003	L.001
		13/12/88	2	2	140	0.001	0.16	0.1	0.001	0.0009	0.05	0.05	L.001	L.001	0.05	0.02	L.001	L.001	L.001	L.001
		02/03/89	9	0	90	L.001	0.04	0.01	0.0011	0.0002	0.08	0.08	L.001	L.001	0.15	0.15	L.001	L.001	L.001	L.001
Wabasca R.	00AL07JD1000	11/05/88	96	L4.	560	0.001	1.16	0.02	0.0036	0.001	0.13	0.09	L.001	L.001	0.06	0.04	L.001	L.001	0.004	0.001
		21/06/88	11	4	1600	0.001	1.76	0.01	0.0041	0.0007	0.09	0.06	0.001	L.001	0.05	0.03	L.001	0.001	0.003	0.003
		19/07/88	900	13	5600	0.001	14.1	0.02	0.013	0.0011	0.29	0.08	0.001	L.001	0.08	0.04	0.001	L.001	0.018	L.001
		23/08/88	30	11	1700	0.001	0.59	L.01	0.0023	0.0008	0.05	0.05	L.001	L.001	0.05	0.03	L.001	L.001	0.001	L.001
		29/09/88	110	8	600	0.002	0.35	0.03	0.0012	0.0006	0.04	0.04	L.001	L.001	0.07	0.06	L.001	L.001	0.007	L.001
		14/12/88	4	0	30	L.001	0.08	0.03	0.0009	0.0008	0.05	0.04	L.001	L.001	L.01	0.01	L.001	L.001	L.001	L.001
		02/03/89	80	4	20	L.001	0.04	0.01	0.0009	0.0009	0.05	0.05	L.001	L.001	0.14	0.14	L.001	L.001	L.001	L.001
Mikkwa River	00AL07JD1000	19/07/88	1600	4	5800	0.001	1.54	0.03	0.0023	0.0006	0.07	0.07	L.001	L.001	0.03	0.02	L.001	L.001	L.001	L.001
		23/08/88	50	50	1700	0.001	0.06	0.06	0.0028	0.001	0.05	0.04	L.001	L.001	0.05	0.02	L.001	L.001	0.002	L.001
		14/12/88	8	0	70	L.001	0.1	L.01	0.0008	0.0008	0.04	0.04	L.001	L.001	0.03	L.01	L.001	L.001	L.001	L.001
		02/03/89	11	2	40	L.001	0.03	0.02	0.0009	0.0009	0.05	0.05	L.001	L.001	0.11	0.11	L.001	L.001	0.051	0.001
Wentzel R.-mouth	00AL07KA1500	11/05/88	76	12	1100	0.001	3	0.02	0.0026	0.0005	0.11	0.09	L.001	L.001	0.05	0.01	L.001	L.001	0.007	L.001
Wentzel R.-Hwy.58	00AL07KA1000	21/06/88	17	17	500	L.001	0.28	0.05	0.0009	0.0006	0.02	0.04	L.001	L.001	0.03	L.01	L.001	0.001	L.001	L.001
		19/07/88	170	8	66000	0.002	0.55	0.01	0.0014	0.0006	0.04	0.04	L.001	L.001	0.03	L.01	L.001	L.001	L.001	L.001
Wentzel R.-mouth	00AL07KA1500	23/08/88	80	30	3800	0.001	0.75	0.03	0.0019	L.0002	0.05	0.05	L.001	L.001	0.04	0.02	L.001	L.001	0.007	0.003
		29/09/88	70	23	310	0.002	0.08	0.03	0.0005	0.0004	0.03	0.03	L.001	L.001	0.06	0.03	L.001	L.001	L.001	L.001
		14/12/88	6	0	40	0.001	0.1	0.02	0.0006	0.0006	0.05	0.05	L.001	L.001	0.11	0.11	L.001	L.001	L.001	L.001
		02/03/89	50	17	50	L.001	0.03	0.02	0.0004	0.0003	0.12	0.12	L.001	L.001	0.12	0.12	L.001	L.001	0.002	L.001
PR u/s Wood Buffalo-c	00AL07KA2000	11/05/88	190	L4.	3500	L.001	4	0.01	0.0038	0.0004	0.25	0.13	L.001	L.001	0.08	0.04	0.001	L.001	0.021	0.001
		21/06/88	22	22	1200	L.001	18.9	0.01	0.0083	0.0005	0.23	0.08	0.002	L.001	0.05	0.02	0.001	L.001	0.005	L.001
		19/07/88	1100	130	50000	0.004	19	0.02	0.024	0.0009	0.39	0.11	0.002	L.001	0.12	0.03	L.001	0.001	0.011	0.008
		23/08/88	23	13	250	0.001	0.25	L.01	0.0008	L.0002	0.05	0.05	L.001	L.001	0.03	0.02	L.001	L.001	0.003	L.001
		29/09/88	30	4	300	L.001	0.42	0.02	0.001	0.0003	0.06	0.04	L.001	L.001	0.14	0.05	L.001	L.001	L.001	L.001
		14/12/88	70	30	20	L.001	0.08	0.04	0.0005	0.0004	0.04	0.04	L.001	L.001	L.01	L.01	L.001	L.001	L.001	L.001
		02/03/89	50	2	290	L.001	0.05	0.02	0.0006	0.0003	0.05	0.04	L.001	L.001	0.06	0.06	L.001	L.001	0.002	0.002
PR nr Peace Point-c	00AL07KC1000	11/05/88	80	16	4000	0.001	14.5	0.03	0.0041	0.0006	0.27	0.09	L.001	L.001	0.1	0.08	0.001	0.001	0.011	0.004
		21/06/88	80	30	1400	L.001	29	0.05	0.02	0.0005	0.46	0.09	L.001	L.001	0.09	0.01	0.001	L.001	0.025	L.001
		19/07/88	600	50	41000	0.001	11	0.01	0.011	0.0007	0.3	0.12	0.001	L.001	0.06	0.02	0.001	0.002	0.013	L.001
		23/08/88	0	0	330	0.001	0.25	0.03	0.0014	0.0002	0.05	0.05	L.001	L.001	0.04	0.01	L.001	L.001	L.001	L.001
		29/09/88	8	0	100	L.001	0.24	0.02	0.0007	L.0002	0.05	0.04	L.001	L.001	L.01	0.03	L.001	L.001	L.001	L.001
		14/12/88	50	22	190	L.001	1.58	0.22	0.0025	0.0005	0.11	0.05	L.001	L.001	L.01	L.01	L.001	L.001	L.001	L.001
		02/03/89	30	0	250	L.001	0.04	0.04	0.0004	0.0003	0.04	0.04	L.001	L.001	0.07	0.07	L.001	L.001	0.001	0.001

Appendix V. Continued.

Station	Code	Date D/M/Y	Total Co mg/L 27002	Diss. Co mg/L 27102	Total Cu mg/L 29005	Diss. Cu mg/L 29105	Total Fe mg/L 26004	Diss. Fe mg/L 26104	Total Pb mg/L 82002	Diss. Pb mg/L 82103	Total Mn mg/L 25004	Diss. Mn mg/L 25104	Total Mo mg/L 42006	Diss. Mo mg/L 42102	Total Ni mg/L 28002	Diss. Ni mg/L 28102	Total Se mg/L 34005	Diss. Se mg/L 34102
PR nr border-c	00BC07FD1050	09/05/88	0.002	L.001	0.005	0.002	7.4	0.07	0.004	L.002	0.091	L.004	0.021	0.009	0.014	0.002	0.0006	0.0003
		20/06/88	L.001	L.001	0.002	L.001	0.91	0.03	L.002	L.002	0.018	0.004	L.001	L.001	0.004	L.001	0.0002	L.0002
		21/07/88	L.001	0.002	0.003	0.002	1.67	0.08	0.002	L.002	0.02	L.004	0.001	L.001	0.018	0.002	L.0002	L.0002
		22/08/88	L.001	L.001	L.001	0.001	0.27	0.04	0.005	0.003	0.01	L.004	L.001	L.001	0.002	0.001	0.0002	L.0002
		03/10/88	L.001	L.001	L.001	L.001	0.24	0.02	L.002	L.002	0.008	L.004	L.001	L.001	L.001	L.001	L.0002	L.0002
		13/12/88	L.001	L.001	0.001	0.001	0.09	L.01	L.002	L.002	L.004	L.004	0.002	L.001	0.002	L.001	0.0002	0.0002
		28/02/89	L.001	L.001	0.002	0.002	0.08	0.01	L.002	L.002	L.004	L.004	L.001	L.001	0.003	L.001	0.0006	0.0002
Pouce Coupe R.	00AL07FD0500	09/05/88	L.001	L.001	0.004	0.003	0.08	0.05	L.002	L.002	0.066	L.004	0.014	0.01	0.008	0.004	0.0005	0.0005
		20/06/88	0.003	L.001	0.009	0.003	5.12	0.33	0.002	L.002	0.092	0.005	L.001	L.001	0.012	0.003	0.0003	0.0002
		21/07/88	L.001	0.002	0.005	0.003	2.47	0.37	0.003	L.002	0.048	0.004	L.001	0.003	0.021	0.005	0.0003	L.0002
		22/08/88	0.002	L.001	0.002	0.002	0.4	0.01	0.003	0.002	0.028	L.004	L.001	L.001	0.006	0.005	0.0003	0.0003
		27/09/88	L.001	L.001	0.003	0.003	0.28	L.01	L.002	L.002	0.024	0.014	0.008	0.008	0.005	0.003	0.0002	0.0002
		12/12/88	0.001	L.001	0.003	0.002	0.49	L.01	L.002	L.002	0.011	L.004	0.002	L.001	0.007	0.001	0.0004	0.0004
		28/02/89	0.001	0.001	0.004	0.002	1.69	0.02	0.005	L.002	0.74	0.69	L.001	L.001	0.004	0.004	0.0005	0.0004
PR nr Dunvegan-cmp	00AL07FD1600	09/05/88	0.006	L.001	0.026	0.003	20	0.01	0.009	L.002	0.245	L.004	0.095	0.014	0.028	0.002	0.001	0.0004
		20/06/88	0.002	L.001	0.004	0.001	1.65	0.02	L.002	L.002	0.028	L.004	L.001	0.002	0.005	0.002	0.0002	0.0002
		21/07/88	L.001	L.001	0.005	0.002	2.82	0.11	0.005	0.002	0.035	L.004	L.001	0.001	0.004	0.003	0.0003	L.0002
		22/08/88	L.001	L.001	L.001	0.001	0.31	0.06	0.004	0.002	0.008	L.004	L.001	L.001	0.006	0.002	0.0002	L.0002
		27/09/88	L.001	L.001	0.002	0.002	0.18	0.02	L.002	L.002	0.005	L.004	0.006	0.004	0.001	0.001	L.0002	L.0002
		12/12/88	L.001	L.001	0.002	L.001	0.08	L.01	L.002	L.002	L.004	L.004	L.001	L.001	0.002	L.001	0.0002	0.0002
PR nr Dunvegan-c	00AL07FD1525	28/02/89	L.001	L.001	0.001	0.001	0.06	0.01	0.002	L.002	L.004	L.004	L.001	L.001	0.002	0.002	0.0003	0.0003
PR u/s Smoky R.-cmp	00AL07FD4600	09/05/88	L.001	L.001	0.01	0.002	5.3	0.08	L.002	L.002	0.06	L.004	0.012	0.006	0.008	0.003	0.0004	0.0002
		09/05/88	L.001	L.001	0.01	0.002	5.4	0.04	L.002	L.002	0.059	L.004	0.015	0.009	0.01	0.002	0.0004	0.0003
		09/05/88	0.002	L.001	0.008	0.002	5.4	0.1	L.002	L.002	0.05	L.004	0.054	0.012	0.008	0.002	0.0005	0.0002
		20/06/88	0.002	L.001	0.005	0.001	2.7	0.06	L.002	L.002	0.044	L.004	L.001	L.001	0.006	L.001	0.0004	0.0002
		21/07/88	0.003	L.001	0.003	0.003	0.09	0.01	0.003	0.002	0.24	0.024	L.001	L.001	0.012	0.003	0.0008	L.0002
		22/08/88	L.001	L.001	L.001	L.001	0.27	0.03	L.002	L.002	0.009	L.004	0.001	L.001	0.006	0.001	0.0002	L.0002
		28/09/88	L.001	L.001	0.002	L.001	0.13	0.03	L.002	L.002	0.004	L.004	0.01	L.001	L.001	L.001	L.0002	L.0002
		12/12/88	0.002	L.001	0.002	L.001	0.11	L.01	L.002	L.002	L.004	L.004	0.002	L.001	0.002	L.001	0.0002	0.0002
PR u/s Smoky R.-c	00AL07FD4575	28/02/89	0.002	L.001	0.004	0.002	2.63	0.01	0.003	L.002	0.059	L.004	L.001	L.001	0.003	0.002	0.0003	0.0003
P.R.Corr.Inst. STP	21AL07FD1000	09/05/88	L.001	L.001	0.015	0.011	0.04	L.01	0.002	L.002	L.004	L.004	0.01	0.003	0.002	L.001	0.0002	0.0002
		20/06/88	0.002	L.001	0.014	0.013	0.13	L.01	0.003	L.002	0.005	L.004	0.002	L.001	0.002	0.006	L.0002	L.0002
		21/07/88	0.002		0.021		0.23		0.003		0.006		L.001		0.004		L.0002	
		29/08/88	L.001		0.014		0.1		L.002		0.005		L.001		0.002		L.0002	
		28/09/88	L.001		0.015		0.05		L.002		L.004		L.001		0.001		L.0002	
		14/12/88	L.001		0.006		0.03		L.002		0.005		L.001		L.001		0.0003	
		01/03/89	L.001		0.016		0.07		L.002		0.008		0.002		0.002		L.0002	
Smoky R.	00AL07GJ4995	09/05/88	L.001	L.001	0.005	0.001	1.6	0.03	L.002	L.002	0.03	L.004	0.01	0.006	0.004	L.001	0.0003	0.0003
		20/06/88	0.004	L.001	0.012	0.002	7.76	0.11	0.003	L.002	0.14	L.004	L.001	L.001	0.012	L.001	0.0005	L.0002
		21/07/88	0.004	0.003	0.005	0.002	3.36	0.05	0.004	0.002	0.058	0.005	L.001	L.001	0.005	0.003	0.0003	L.0002
		22/08/88	L.001	L.001	L.001	0.001	0.79	0.02	0.002	L.002	0.018	L.004	0.002	L.001	0.003	0.002	0.0003	L.0002
		27/09/88	L.001	L.001	L.001	L.001	0.31	0.03	L.002	L.002	0.015	0.005	0.006	0.009	0.001	0.001	L.0002	L.0002
		12/12/88	0.001	L.001	0.002	L.001	0.16	0.03	L.002	L.002	0.01	0.005	L.001	L.001	0.001	L.001	L.0002	L.0002
		01/03/89	L.001	L.001	0.003	L.001	0.17	0.07	L.002	L.002	0.016	0.015	0.029	L.001	0.001	0.001	0.0002	0.0002
Grande Prairie STP	21AL07GE1000	09/05/88	L.001	L.001	0.005	0.003	0.17	0.02	0.002	L.002	0.052	0.002	0.011	0.01	0.003	L.001	0.0002	L.0002
		20/06/88	L.001	L.001	0.004	0.003	0.57	0.37	0.006	0.006	0.035	0.03	L.001	L.001	0.008	0.008	0.0004	0.0004

Appendix V. Continued.

Station	Code	Date D/M/Y	Total Co mg/L 27002	Diss. Co mg/L 27102	Total Cu mg/L 29005	Diss. Cu mg/L 29105	Total Fe mg/L 26004	Diss. Fe mg/L 26104	Total Pb mg/L 82002	Diss. Pb mg/L 82103	Total Mn mg/L 25004	Diss. Mn mg/L 25104	Total Mo mg/L 42006	Diss. Mo mg/L 42102	Total Ni mg/L 28002	Diss. Ni mg/L 28102	Total Se mg/L 34005	Diss. Se mg/L 34102
Grande Prairie STP	21AL07GE1000	13/07/88	L.001	L.001	0.02	0.011	0.33	0.01	0.006	0.003	0.1	L.004	0.012	0.008	0.006	0.004	0.0006	0.0004
		04/01/89	0.002		0.006		0.17		0.004		0.092		0.001		0.004		0.0004	
		02/03/89	0.002		0.006		0.226				0.092		0.002		0.007			
P&G Effluent-grab	20AL07GE8000	11/05/88	0.002	L.001	0.008	0.006	1	0.65	0.003	L.002	0.778	0.752	0.045	0.042	0.01	0.009	L.0002	L.0002
		20/06/88	L.001	L.001	0.008	0.007	1.67	1.54	0.007	0.007	0.71	0.71	0.003	0.002	0.02	0.02	0.0002	0.0002
		13/07/88	L.001	L.001	0.01	0.01	1.14	0.49	0.023	0.015	1.02	0.88	0.003	L.001	0.02	0.016	L.0002	L.0002
		22/08/88	L.001		0.007		0.86		0.003		0.86		0.005		0.006		L.0002	
		19/09/88	L.001		0.016		0.68		L.002		0.52		0.002		0.012		L.0002	
		15/12/88	L.001		0.002		0.76		L.002		0.92		L.001		0.005		0.0003	
P&G Effluent-cmp	20AL07GE8001	02/03/89	0.005		0.008		0.621		L.002		0.835		0.006		0.011		L.0002	
Peace River STP	21AL07HA1000	10/05/88	L.001	L.001	0.064	0.035	0.76	0.03	0.008	0.005	0.071	0.008	0.006	L.001	0.006	0.003	L.0002	L.0002
		20/06/88	0.001		0.077		0.77		0.005		0.1		0.002		0.008		L.0002	
		21/07/88	0.002		0.047		0.79		0.007		0.13		0.001		0.006		L.0002	
		22/08/88	0.004		0.036		0.69		0.01		0.1		0.003		0.009		L.0002	
		27/09/88	L.001		0.038		0.92		0.004		0.1		0.005		0.008		0.0002	
		12/12/88	L.001		0.06		0.95		0.011		0.078		0.004		0.002		0.0004	
		01/03/89	L.001		0.048		0.67		0.005		0.066		L.001		0.002		0.0004	
Peace River Oils	00AL07HA2400	17/05/88	L.001		0.001		0.97		L.002		0.054		0.013		0.001		L.0002	
		04/10/88	L.001		L.001		0.02		L.002		0.04		0.008		L.001		L.0002	
		01/03/89	L.001		0.004				L.002		0.048		0.001		L.001		0.0003	
PR u/s Whitemud R.-cmp	00AL07HA2850	10/05/88	0.002	L.001	0.012	0.003	4.9	0.06	0.006	L.002	0.056	0.005	0.012	0.003	0.012	0.003	0.0004	L.0002
		20/06/88	0.003	L.001	0.006	0.001	3.72	0.08	0.002	L.002	0.057	0.004	L.001	0.008	0.01	0.001	0.0003	L.0002
		21/07/88	0.004	0.003	0.007	0.002	5.27	0.12	0.003	0.002	0.062	L.004	L.001	L.001	0.009	0.002	0.0003	L.0002
		22/08/88	L.001	L.001	L.001	0.001	0.22	0.03	0.002	L.002	0.007	L.004	0.001	L.001	L.001	L.001	L.0002	L.0002
		28/09/88	L.001	L.001	0.001	0.001	0.21	0.02	L.002	L.002	0.005	L.004	0.002	L.001	0.004	L.001	0.0002	0.0002
		12/12/88	L.001	L.001	0.004	L.001	0.1	0.01	L.002	L.002	L.004	L.004	L.001	L.001	0.002	L.001	0.0003	0.0002
PR u/s Whitemud R.-c	00AL07HA2820	01/03/89	L.001	L.001	0.004	L.001	0.07	0.02	L.002	L.002	L.004	L.004	L.001	L.001	0.006	0.004	0.0003	0.0002
Whitemud R.	00AL07HA3000	09/05/88	0.004	L.001	0.02	0.002	13	0.08	L.002	L.002	0.176	L.004	0.021	0.01	0.02	0.005	0.0006	L.0002
		20/06/88	0.005	L.001	0.011	0.003	17.3	0.25	0.014	L.002	0.27	0.059	0.003	0.003	0.013	0.007	0.0009	0.0003
		21/07/88	0.014	0.005	0.009	0.003	2.72	0.42	0.003	0.002	0.41	0.041	0.004	0.004	0.046	0.006	0.0012	L.0002
		22/08/88	0.004	0.003	0.004	0.002	7.23	0.23	0.004	L.002	0.23	0.012	0.004	L.001	0.009	0.008	0.0004	0.0002
		28/09/88	0.001	L.001	0.002	0.001	2.27	0.64	L.002	L.002	0.049	0.037	L.001	L.001	0.01	0.006	L.0002	L.0002
		12/12/88	0.003	0.001	0.002	L.001	2.85	0.09	L.002	L.002	0.12	0.11	L.001	L.001	0.012	0.005	0.0006	0.0003
		01/03/89	L.001	L.001	0.004	0.002	1.56	0.02	L.002	L.002	0.24	0.16	0.044	L.001	0.008	0.005	0.0003	0.0003
Cadotte R.	00AL07HB1000	09/05/88	L.001	L.001	0.008	0.001	5.9	0.02	L.002	L.002	0.12	L.004	0.013	0.011	0.008	L.001	0.0004	0.0002
		20/06/88	0.005	L.001	0.012	0.002	9.62	0.1	0.004	L.002	0.23	0.004	L.001	L.001	0.012	0.005	0.0005	0.0002
		21/07/88	0.01	0.004	0.004	0.003	0.15	0.14	0.003	L.002	0.37	0.012	L.001	L.001	0.027	0.005	0.0007	L.0002
		22/08/88	L.001	L.001	L.001	L.001	1	0.11	0.002	L.002	0.047	0.004	L.001	L.001	0.003	0.003	L.0002	L.0002
		28/09/88	L.001	L.001	0.001	0.001	0.53	0.15	L.002	L.002	0.025	0.018	L.001	L.001	0.006	0.003	L.0002	L.0002
		12/12/88	L.001	L.001	0.002	0.001	1.05	0.22	0.002	0.002	0.035	0.024	L.001	L.001	0.002	0.002	0.0003	0.0003
		01/03/89	L.001	L.001	0.002	0.001	1	0.15	L.002	L.002	0.054	0.047	0.039	L.001	0.005	0.001	0.0004	0.0003
PR u/s Notikewin R.-c	00AL07HC1200	10/05/88	0.004	L.001	0.012	0.003	6	0.07	0.006	L.002	0.067	L.004	0.013	L.001	0.013	0.005	0.0004	0.0002
		20/06/88	0.003	L.001	0.006	0.001	4.4	0.013	0.004	L.002	0.083	L.004	0.004	0.006	0.009	0.001	0.0004	0.0002
		20/06/88	0.003	L.001	0.007	0.002	4.69	0.11	0.006	L.002	0.08	L.004	L.001	0.001	0.012	0.002	0.0003	0.0002
		20/06/88	0.002	L.001	0.006	0.004	5.09	0.11	0.003	L.002	0.076	L.004	0.009	0.002	0.008	0.001	0.0003	L.0002
		19/07/88	0.005	L.001	0.015	0.002	10.6	0.15	0.009	0.007	0.204	L.004	0.005	0.005	0.032	0.007	L.0002	L.0002

Appendix V. Continued.

Station	Code	Date D/M/Y	Total Co mg/L 27002	Diss. Co mg/L 27102	Total Cu mg/L 29005	Diss. Cu mg/L 29105	Total Fe mg/L 26004	Diss. Fe mg/L 26104	Total Pb mg/L 82002	Diss. Pb mg/L 82103	Total Mn mg/L 25004	Diss. Mn mg/L 25104	Total Mo mg/L 42006	Diss. Mo mg/L 42102	Total Ni mg/L 28002	Diss. Ni mg/L 28102	Total Se mg/L 34005	Diss. Se mg/L 34102
PR u/s Notikewin R.-c	00AL07HC1200	22/08/88	L.001	L.001	L.001	L.001	0.43	0.02	L.002	L.002	0.012	L.004	0.001	0.001	L.001	L.001	L.0002	L.0002
		22/08/88	0.001	L.001	L.001	L.001	0.4	0.04	L.002	L.002	0.014	L.004	L.001	L.001	0.002	0.002	L.0002	L.0002
		22/08/88	L.001	L.001	L.001	L.001	0.37	0.03	L.002	L.002	0.011	L.004	L.001	L.001	0.001	0.001	L.0002	L.0002
		28/09/88	L.001	L.001	0.001	0.001	0.3	0.03	L.002	L.002	0.009	L.004	L.001	L.001	0.002	L.001	L.0002	L.0002
		13/12/88	0.001	L.001	0.002	L.001	0.1	0.02	L.002	L.002	0.005	L.004	L.001	L.001	0.002	L.001	0.0004	0.0004
		01/03/89	L.001	L.001	0.001	L.001	0.07	0.01	L.002	L.002	L.004	L.004	L.001	L.001	L.001	L.001	0.0003	0.0003
Notikewin R.	00AL07HC1400	10/05/88	0.004	L.001	0.014	0.003	7	0.3	0.009	0.002	0.076	L.004	0.02	0.003	0.02	0.006	0.0004	0.0002
		20/06/88	0.002	L.001	0.004	0.003	2.14	0.39	0.002	L.002	0.039	0.007	L.001	L.001	0.007	0.004	0.0002	0.0002
		19/07/88	0.011	L.001	0.026	0.005	24.8	0.41	0.016	0.004	0.333	0.012	L.001	L.001	0.064	0.008	L.0002	L.0002
		22/08/88	0.002	L.001	0.002	L.001	3.66	0.49	L.002	L.002	0.097	L.004	0.004	L.001	0.006	0.006	0.0003	0.0003
		28/09/88	L.001	L.001	0.002	0.002	0.86	0.5	L.002	L.002	0.016	0.008	0.006	L.001	0.003	L.001	0.0003	0.0003
		13/12/88	L.001	L.001	0.003	0.002	1.8	0.75	L.002	L.002	0.023	0.014	L.001	L.001	0.006	0.002	L.0002	L.0002
		01/03/89	L.001	L.001	0.005	0.003	2.44	0.1	0.01	L.002	0.17	0.035	L.001	L.001	0.012	0.003	0.0003	0.0003
PR nr Carcajou-c	00AL07HD1030	10/05/88	0.004	L.001	0.011	0.003	5.3	0.04	0.004	L.002	0.061	L.004	0.006	L.001	0.012	0.002	0.0005	0.0002
		21/06/88	L.001	L.001	L.001	0.002	0.01	0.03	L.002	L.002	0.075	L.004	L.001	0.001	0.004	0.001	0.0003	L.0002
		19/07/88	0.011	L.001	0.024	0.004	18.8	0.16	0.016	0.004	0.227	L.004	0.003	0.003	0.062	0.006	L.0002	L.0002
		23/08/88	L.001	L.001	0.001	0.001	0.21	0.05	0.002	0.002	0.007	L.004	L.001	L.001	0.001	0.001	L.0002	L.0002
		28/09/88	L.001	L.001	0.001	0.001	0.32	0.03	L.002	L.002	0.009	L.004	0.007	L.001	0.001	L.001	0.0003	0.0002
		13/12/88	L.001	L.001	0.002	0.001	0.07	0.02	L.002	L.002	0.004	L.004	L.001	L.001	0.001	0.001	L.0002	L.0002
		01/03/89	L.001	L.001	L.001	L.001	0.2	0.02	0.004	L.002	0.005	L.004	0.004	L.001	0.01	0.004	0.0003	0.0003
Wolverine R.	00AL07HE1000	10/05/88	0.008	L.001	0.02	0.003	12	0.05	0.009	L.002	0.225	L.004	0.027	L.001	0.02	0.005	0.0005	0.0003
		21/06/88	0.001	L.001	0.007	0.003	4.97	0.18	0.004	L.002	0.18	0.004	L.001	L.001	0.01	0.004	0.0004	0.0003
		19/07/88	0.011	L.001	0.026	0.004	22.1	0.29	0.013	0.003	0.335	0.012	0.009	L.001	0.064	0.008	L.0002	L.0002
		23/08/88	0.001	0.001	0.004	0.002	3	0.34	0.005	0.005	0.13	0.004	L.001	L.001	0.006	0.006	L.0002	L.0002
		28/09/88	L.001	L.001	0.002	0.001	1.38	0.17	L.002	L.002	0.077	0.008	0.001	L.001	0.002	L.001	0.0003	0.0002
		13/12/88	L.001	L.001	0.003	0.001	2.1	0.45	L.002	L.002	0.077	0.044	0.001	L.001	0.005	0.004	L.0002	L.0002
Keg R.	00AL07HF1300	10/05/88	0.008	L.001	0.017	0.004	8.8	0.16	0.009	0.002	0.209	L.004	0.02	0.01	0.022	0.005	0.0007	0.0003
		21/06/88	0.001	L.001	0.006	0.004	3.48	0.25	0.005	L.002	0.084	0.019	0.006	L.001	0.01	0.007	0.0004	0.0003
		19/07/88	0.005	L.001	0.014	0.004	8.83	0.35	0.009	0.005	0.135	0.015	L.001	L.001	0.027	0.01	0.0002	0.0002
		23/08/88	0.001	L.001	0.003	0.003	1.99	0.27	L.002	L.002	0.07	0.01	0.002	L.001	0.006	0.005	L.0002	L.0002
		28/09/88	L.001	L.001	0.003	0.003	1.15	0.09	L.002	L.002	0.065	0.008	0.004	0.001	0.004	L.001	0.0003	0.0002
		13/12/88	L.001	L.001	0.003	0.002	2.15	0.54	L.002	L.002	0.046	0.037	L.001	L.001	0.006	0.003	L.0002	L.0002
		01/03/89	L.001	L.001	0.014	0.002	1.77	0.14	L.002	L.002	0.084	0.064	L.001	L.001	0.012	0.003	0.0002	0.0002
PR nr La Crete-c	00AL07HF1530	10/05/88	0.004	L.001	0.011	0.003	6.1	0.05	0.007	L.002	0.071	L.004	0.014	0.013	0.014	0.002	0.0003	0.0003
		21/06/88	0.002	L.001	0.007	0.003	5.47	0.16	0.005	L.002	0.09	L.004	0.005	L.001	0.012	0.005	0.0004	L.0002
		19/07/88	0.009	L.001	0.026	0.004	24.3	0.21	0.012	0.006	0.307	L.004	0.008	0.007	0.038	0.011	L.0002	L.0002
		23/08/88	L.001	L.001	0.002	L.001	0.21	0.02	0.004	0.004	0.007	L.004	L.001	L.001	L.001	L.001	L.0002	L.0002
		28/09/88	L.001	L.001	0.002	L.001	0.3	0.02	L.002	L.002	L.004	L.004	L.001	L.001	0.002	L.001	L.0002	L.0002
		13/12/88	L.001	L.001	0.002	0.001	0.19	L.01	L.002	L.002	0.026	0.021	0.003	0.002	0.001	0.001	L.0002	L.0002
		02/03/89	L.001	L.001	0.002	L.001	0.12	0.02	L.002	L.002	0.006	L.004	0.031	L.001	0.003	0.002	0.0008	L.0002
PR nr Ft. Vermilion-c	00AL07HF1720	11/05/88	0.007	L.001	0.012	0.004	7.1	0.08	0.007	L.002	0.083	L.004	0.022	0.006	0.018	0.004	L.0002	L.0002
		21/06/88	0.006	L.001	0.012	0.003	7.96	0.13	0.007	L.002	0.13	L.004	0.012	0.007	0.016	0.003	0.0005	L.0002
		19/07/88	0.012	L.001	0.03	0.004	28.7	0.12	0.02	0.006	0.354	L.004	0.007	L.001	0.04	0.011	L.0002	L.0002
		23/08/88	0.001	L.001	0.026	L.001	0.45	0.03	0.003	0.003	0.012	L.004	0.001	L.001	0.005	0.005	L.0002	L.0002
		29/09/88	L.001	L.001	0.004	L.001	2.85	0.94	0.002	0.002	0.059	0.036	L.001	L.001	0.006	0.003	L.0002	L.0002
		13/12/88	0.001	L.001	0.002	0.001	0.09	0.02	L.002	L.002	0.01	0.006	L.001	L.001	0.003	L.001	0.0003	L.0002

Appendix V. Continued.

Station	Code	Date D/M/Y	Total Co mg/L 27002	Diss. Co mg/L 27102	Total Cu mg/L 29005	Diss. Cu mg/L 29105	Total Fe mg/L 26004	Diss. Fe mg/L 26104	Total Pb mg/L 82002	Diss. Pb mg/L 82103	Total Mn mg/L 25004	Diss. Mn mg/L 25104	Total Mo mg/L 42006	Diss. Mo mg/L 42102	Total Ni mg/L 28002	Diss. Ni mg/L 28102	Total Se mg/L 34005	Diss. Se mg/L 34102
PR nr Ft. Vermilion-c	00AL07HF1720	13/12/88	L.001	L.001	0.002	0.001	0.08	0.02	0.003	L.002	0.008	0.008	0.001	L.001	L.001	L.001	0.0005	L.0002
		13/12/88	L.001	L.001	0.002	L.001	0.09	0.01	L.002	L.002	0.008	0.005	L.001	L.001	0.002	L.001	0.0003	0.0002
		02/03/89	L.001	L.001	0.002	0.001	0.13	0.02	L.002	L.002	0.006	L.004	L.001	L.001	0.002	0.001	0.0004	0.0004
		02/03/89	L.001	L.001	0.002	0.001	0.12	0.02	L.002	L.002	0.005	0.005	L.001	L.001	0.002	0.001	L.0002	L.0002
		02/03/89	L.001	L.001	0.002	L.001	0.12	0.02	L.002	L.002	0.005	L.004	L.001	L.001	0.001	L.001	0.0004	L.0002
Ft. Vermilion STP	21AL07HF1000	24/05/88	L.001	L.001	0.005	0.003	0.78	0.07	L.002	L.002	0.303	0.058	0.004	L.001	0.005	0.005	0.0002	0.0002
Boyer R.	00AL07JF1000	10/05/88	0.028	L.001	0.11	0.006	6.7	0.32	0.038	L.002	0.97	L.004	0.081	0.005	0.098	0.006	0.0031	0.0004
		21/06/88	0.004	L.001	0.013	0.004	7.22	0.31	0.008	L.002	0.11	0.013	0.01	0.001	0.016	0.007	0.0007	0.0002
		19/07/88	0.004	L.001	0.01	0.004	8.11	0.3	0.008	0.004	0.118	0.012	0.002	0.002	0.011	0.01	L.0002	L.0002
		23/08/88	0.007	L.001	0.018	0.002	25	0.5	0.026	0.004	0.15	0.007	L.001	L.001	0.023	0.006	L.0002	L.0002
		29/09/88	L.001	L.001	L.001	L.001	0.31	0.02	L.002	L.002	0.009	L.004	L.001	L.001	0.001	0.001	L.0002	L.0002
		13/12/88	L.001	L.001	0.003	0.003	1.47	0.73	L.002	L.002	0.1	0.092	L.001	L.001	0.007	0.003	0.0005	0.0004
		02/03/89	L.001	L.001	0.005	0.003	1.02	0.12	L.002	L.002	0.46	0.45	0.053	0.002	0.009	0.009	0.0007	0.0002
Wabasca R.	00AL07JD1000	11/05/88	0.007	L.001	0.01	0.003	4.8	0.29	0.008	L.002	0.147	0.009	0.014	L.001	0.018	0.005	0.0003	0.0003
		21/06/88	0.004	L.001	0.008	0.003	4.54	0.24	0.005	L.002	0.14	0.004	0.004	0.001	0.012	0.007	0.0003	L.0002
		19/07/88	0.01	0.003	0.025	0.004	24.4	0.32	0.012	0.007	0.332	0.021	0.006	0.006	0.027	0.012	L.0002	L.0002
		23/08/88	0.002	L.001	L.001	0.001	2.44	0.26	0.004	0.003	0.16	L.004	L.001	L.001	0.006	0.005	L.0002	L.0002
		29/09/88	L.001	L.001	0.001	L.001	1.32	0.2	0.002	0.002	0.086	0.011	0.004	0.004	0.003	0.003	L.0002	L.0002
		14/12/88	L.001	L.001	0.002	0.001	1.02	0.31	0.002	L.002	0.063	0.023	L.001	L.001	0.005	0.002	0.0004	L.0002
		02/03/89	L.001	L.001	0.003	0.002	0.82	0.38	L.002	L.002	0.072	0.067	0.004	L.001	0.004	0.004	0.0003	L.0002
Nikkwa R.	00AL07JE1000	19/07/88	0.004	L.001	0.004	0.002	4.02	0.41	0.004	0.007	0.078	0.007	0.008	0.008	L.001	L.001	0.0004	0.0007
		23/08/88	L.001	L.001	0.002	L.001	1.35	1.01	0.01	0.003	0.044	0.01	0.002	L.001	0.005	0.005	L.0002	L.0002
		14/12/88	L.001	L.001	0.001	L.001	1.27	0.81	L.002	L.002	0.06	0.041	0.001	L.001	0.004	0.003	0.0005	0.0002
		02/03/89	L.001	L.001	0.002	L.001	1.1	0.82	L.002	L.002	0.081	0.073	0.012	0.002	0.005	0.005	0.0005	L.0002
Wentzel R.-mouth	00AL07KA1500	11/05/88	0.005	L.001	0.01	0.003	7.5	0.23	0.006	L.002	0.113	0.017	0.01	L.001	0.014	0.004	0.0002	0.0002
Wentzel R.-Hwy.58	00AL07KA1000	21/06/88	L.001	L.001	0.003	0.002	0.78	0.23	L.002	L.002	0.024	0.008	L.001	0.002	0.003	0.004	0.0002	L.0002
		19/07/88	0.004	0.004	0.029	0.002	1.4	0.52	0.003	0.005	0.036	0.007	0.012	L.001	0.006	0.002	0.0003	0.0002
	00AL07KA1500	23/08/88	L.001	L.001	0.003	0.003	2.55	0.39	0.015	0.008	0.069	0.018	L.001	L.001	0.008	0.004	L.0002	L.0002
		29/09/88	L.001	L.001	L.001	L.001	0.66	0.48	0.002	0.002	0.031	0.025	0.002	0.001	0.002	0.001	L.0002	L.0002
		14/12/88	L.001	L.001	L.001	L.001	0.74	0.51	L.002	L.002	0.06	0.06	L.001	L.001	0.003	0.003	L.0002	L.0002
		02/03/89	L.001	L.001	0.002	L.001	2.54	0.38	L.002	L.002	0.36	0.35	0.01	L.001	0.003	0.003	0.0006	L.0002
PR u/s Wood Buffalo-c	00AL07KA2000	11/05/88	0.009	L.001	0.02	0.003	13	0.06	0.013	L.002	0.143	0.005	0.023	L.001	0.026	0.002	0.0003	0.0002
		21/06/88	0.006	L.001	0.017	0.003	11.8	0.09	0.008	L.002	0.19	0.004	0.006	L.001	0.02	0.004	0.0006	0.0003
		19/07/88	0.012	0.002	0.002	0.004	30.2	0.24	0.018	L.002	0.355	0.004	0.005	L.001	0.062	0.024	0.0003	L.0002
		23/08/88	L.001	L.001	0.003	0.001	0.61	0.05	0.013	0.006	0.029	L.004	L.001	L.001	0.004	0.002	0.0002	L.0002
		29/09/88	L.001	L.001	0.005	0.002	0.98	0.05	0.003	0.002	0.032	L.004	L.001	L.001	0.002	L.001	0.0002	L.0002
		14/12/88	0.002	0.002	L.001	L.001	0.15	0.01	0.005	L.002	0.006	L.004	0.006	0.006	0.002	0.002	L.0002	L.0002
		02/03/89	L.001	L.001	0.002	0.001	0.14	0.02	L.002	L.002	0.006	L.004	L.001	L.001	0.003	0.002	L.0002	L.0002
PR nr Peace Point-c	00AL07KC1000	11/05/88	0.009	0.001	0.02	0.003	14	0.14	0.008	L.002	0.163	0.007	0.027	0.005	0.026	0.004	0.0003	0.0003
		21/06/88	0.012	L.001	0.033	0.004	27.9	0.14	0.014	L.002	0.47	L.004	0.009	L.001	0.042	0.005	0.0014	0.0002
		19/07/88	0.012	0.002	0.022	0.003	20	0.16	0.018	L.002	0.223	L.004	0.001	0.001	0.057	0.024	L.0002	L.0002
		23/08/88	0.001	L.001	0.003	0.001	0.58	0.06	0.006	0.005	0.029	L.004	L.001	L.001	0.004	0.002	0.0002	L.0002
		29/09/88	L.001	L.001	L.001	0.002	0.51	0.06	0.004	0.002	0.019	L.004	0.003	0.001	0.002	L.001	L.0002	L.0002
		14/12/88	L.001	L.001	0.006	L.001	4.22	0.01	0.004	L.002	0.09	L.004	L.001	L.001	0.007	0.003	L.0002	L.0002
		02/03/89	L.001	L.001	0.002	0.001	0.14	0.01	L.002	L.002	0.006	L.004	L.001	L.001	0.002	0.001	0.0004	0.0004

Appendix V. Continued.

Station	Code	Date D/M/Y	Total Ag mg/L 47005	Diss. Ag mg/L 47102	Total V mg/L 23002	Diss. V mg/L 23102	Total Zn mg/L 30005	Diss. Zn mg/L 30105	Total Hg ug/L 80011
PR nr border-c	00BC07FD1050	09/05/88	L.001	L.001	0.016	0.002	0.038	0.014	L.05
		20/06/88	L.001	L.001	0.002	L.001	0.01	0.022	L.05
		21/07/88	L.001	L.001	0.003	L.001	0.011	0.013	L.05
		22/08/88	L.001	L.001	L.001	L.001	0.004	0.004	L.05
		03/10/88	L.001	L.001	0.005	0.004	0.005	0.005	L.05
		12/12/88	L.001	L.001	L.001	L.001	0.01	0.007	L.05
		28/02/89	L.001	L.001	L.001	L.001	0.004	0.003	L.05
Pouce Coupe R.	00AL07FD0500	09/05/88	L.001	L.001	0.002	L.001	0.01	0.01	L.05
		20/06/88	L.001	L.001	0.011	L.001	0.022	0.008	L.05
		21/07/88	L.001	L.001	L.001	0.001	0.01	0.012	L.05
		22/08/88	L.001	L.001	L.001	L.001	0.002	0.002	L.05
		27/09/88	L.001	L.001	L.001	L.001	0.004	0.003	L.05
		12/12/88	L.001	L.001	L.001	L.001	0.005	0.005	L.05
		28/02/89	L.001	L.001	0.001	L.001	0.017	0.013	L.05
PR nr Dunvegan-cmp	00AL07FD1600	09/05/88	L.001	L.001	0.029	0.001	0.078	0.018	L.05
		20/06/88	L.001	L.001	0.003	L.001	0.01	0.007	L.05
		21/07/88	L.001	L.001	0.006	L.001	0.013	0.008	L.05
		22/08/88	L.001	L.001	L.001	L.001	0.009	L.001	L.05
		27/09/88	L.001	L.001	L.001	L.001	0.003	0.002	L.05
		12/12/88	L.001	L.001	L.001	L.001	0.003	L.001	L.05
PR nr Dunvegan-c	00AL07FD1525	28/02/89	L.001	L.001	0.001	0.001	0.003	0.003	L.05
PR u/s Smoky R.-cmp	00AL07FD4600	09/05/88	L.001	L.001	0.012	L.001	0.054	0.01	L.05
		09/05/88	L.001	L.001	0.01	L.001	0.026	0.011	L.05
		09/05/88	L.001	L.001	0.02	0.002	0.026	0.01	L.05
		20/06/88	L.001	L.001	0.006	L.001	0.022	0.006	L.05
		21/07/88	L.001	L.001	L.001	L.001	0.021	0.015	L.05
		22/08/88	L.001	L.001	L.001	L.001	L.001	L.001	L.05
		28/09/88	L.001	L.001	L.001	L.001	0.004	0.004	L.05
		12/12/88	L.001	L.001	0.001	L.001	0.003	0.002	L.05
PR u/s Smoky R.-c	00AL07FD4575	28/02/89	L.001	L.001	0.003	L.001	0.017	0.017	L.05
P.R.Corr.Inst. STP	21AL07FD1000	09/05/88	L.001	L.001	L.001	L.001	0.042	0.039	L.05
		20/06/88	L.001	L.001	0.004	L.001	0.037	0.035	L.05
		21/07/88	L.001		0.011		0.065		L.05
		29/08/88	L.001		L.001		0.037		
		28/09/88	L.001		L.001		0.039		L.05
		14/12/88	L.001		0.002		0.043		L.05
		01/03/89	L.001		L.001		0.046		L.05
Smoky R.	00AL07GJ4995	09/05/88	L.001	L.001	L.001	L.001	0.01	0.007	L.05
		20/06/88	L.001	L.001	L.001	L.001	0.031	0.007	L.05
		21/07/88	L.001	L.001	L.001	L.001	0.013	0.009	L.05
		22/08/88	L.001	L.001	L.001	L.001	0.001	L.001	L.05
		27/09/88	L.001	L.001	L.001	L.001	0.004	0.004	L.05
		12/12/88	L.001	L.001	L.001	L.001	0.003	0.003	L.05
		01/03/89	L.001	L.001	0.005	L.001	0.006	0.005	L.05
Grande Prairie STP	21AL07GE1000	09/05/88	L.001	L.001	L.001	0.001	0.019	0.014	L.05
		20/06/88	L.001	L.001	0.001	L.001	0.02	0.02	L.05

Appendix V. Continued.

Station	Code	Date D/M/Y	Total Ag mg/L 47005	Diss. Ag mg/L 47102	Total V mg/L 23002	Diss. V mg/L 23102	Total Zn mg/L 30005	Diss. Zn mg/L 30105	Total Hg ug/L 80011
Grande Prairie STP	21AL07GE1000	13/07/88	L.001	L.001	0.005	0.003	0.042	0.038	L.05
		04/01/89	L.001	L.001	0.001	L.001	0.02	0.02	L.05
		02/03/89			0.004		0.028		L.05
P&G Effluent-grab	20AL07GE8000	11/05/88	L.001	L.001	0.01	0.006	0.16	0.09	0.35
		20/06/88	L.001	L.001	0.001	L.001	0.12	0.12	L.05
		13/07/88	L.001	L.001	L.001	L.001	0.33	0.07	L.05
		22/08/88	L.001		0.002		0.11		L.05
		19/09/88	L.001		0.003		0.19		L.05
		15/12/88	L.001		0.005		0.134		L.05
P&G Effluent-cmp	20AL07GE8001	02/03/89			0.01		0.163		L.1
Peace River STP	21AL07HA1000	10/05/88	L.001	L.001	0.001	L.001	0.04	0.04	L.05
		20/06/88	0.001		0.002		0.03		L.05
		21/07/88	0.001		L.001		0.043		L.05
		22/08/88	L.001		L.001		0.04		
		27/09/88	L.001		L.001		0.052		L.05
		12/12/88	0.013		L.001		0.049		L.05
		01/03/89	0.003		L.001		0.048		L.05
Peace River Oils	00AL07HA2400	17/05/88	L.001		0.003		0.005		L.05
		04/10/88	L.001		L.001		0.007		L.05
		01/03/89	0.002		L.001		0.003		L.05
PR u/s Whitemud R.-cmp	00AL07HA2850	10/05/88	L.001	L.001	0.015	L.001	0.028	0.022	L.05
		20/06/88	L.001	L.001	0.009	L.001	0.02	0.011	L.05
		21/07/88	L.001	L.001	0.008	L.001	0.024	0.018	L.05
		22/08/88	L.001	L.001	L.001	L.001	L.001	L.001	L.05
		28/09/88	L.001	L.001	0.003	L.001	0.002	0.002	L.05
		12/12/88	L.001	L.001	L.001	L.001	0.004	0.004	L.05
PR u/s Whitemud R.-c	00AL07HA2820	01/03/89	L.001	L.001	L.001	L.001	0.008	0.004	L.05
Whitemud R.	00AL07HA3000	09/05/88	L.001	L.001	0.021	0.001	0.054	0.025	L.05
		20/06/88	0.003	L.001	0.015	L.001	0.04	0.012	L.05
		21/07/88	L.001	L.001	0.02	L.001	0.021	0.078	L.05
		22/08/88	L.001	L.001	0.005	L.001	0.019	0.009	L.05
		28/09/88	L.001	L.001	0.001	L.001	0.01	0.005	L.05
		12/12/88	L.001	L.001	L.001	L.001	0.011	0.007	L.05
		01/03/89	L.001	L.001	0.005	L.001	0.013	0.005	L.05
Cadotte R.	00AL07HB1000	09/05/88	L.001	L.001	0.006	0.003	0.022	0.007	L.05
		20/06/88	L.001	L.001	0.005	L.001	0.038	0.004	L.05
		21/07/88	L.001	L.001	L.001	L.001	0.12	0.054	L.05
		22/08/88	L.001	L.001	L.001	L.001	0.003	0.003	L.05
		28/09/88	L.001	L.001	L.001	L.001	0.002	0.002	L.05
		12/12/88	L.001	L.001	L.001	L.001	0.005	0.003	L.05
		01/03/89	L.001	L.001	0.004	0.001	0.005	0.005	L.05
PR u/s Notikewin R.-c	00AL07HC1200	10/05/88	L.001	L.001	0.015	0.002	0.032	0.018	L.05
		20/06/88	L.001	L.001	0.001	L.001	0.019	0.006	L.05
		20/06/88	L.001	L.001	0.01	L.001	0.02	0.008	L.05
		20/06/88	L.001	L.001	0.009	L.001	0.021	0.017	L.05
		19/07/88	L.001	L.001	0.018	0.004	0.084	0.017	L.05

Appendix V. Continued.

Station	Code	Date D/M/Y	Total Ag mg/L 47005	Diss. Ag mg/L 47102	Total V mg/L 23002	Diss. V mg/L 23102	Total Zn mg/L 30005	Diss. Zn mg/L 30105	Total Hg ug/L 80011
PR u/s Notikewin R.-c	00AL07HC1200	22/08/88	L.001	L.001	L.001	L.001	L.001	L.001	L.05
		22/08/88	L.001	L.001	0.003	L.001	0.003	0.003	L.05
		22/08/88	L.001	L.001	0.001	L.001	0.004	0.004	L.05
		28/09/88	L.001	L.001	L.001	L.001	0.003	0.001	L.05
		13/12/88	L.001	L.001	L.001	L.001	0.003	0.003	L.05
		01/03/89	L.001	L.001	L.001	L.001	0.01	0.004	L.05
Notikewin R.	00AL07HC1400	10/05/88	L.001	L.001	0.019	0.002	0.028	0.026	L.05
		20/06/88	L.001	L.001	0.006	0.002	0.009	0.01	L.05
		19/07/88	L.001	L.001	0.042	L.001	0.094	0.026	L.05
		22/08/88	L.001	L.001	0.003	L.001	0.011	0.007	L.05
		28/09/88	L.001	L.001	0.002	0.002	0.003	0.003	L.05
		13/12/88	L.001	L.001	L.001	L.001	0.003	0.003	L.05
		01/03/89	L.001	L.001	L.001	L.001	0.009	0.006	L.05
PR nr Carcajou-c	00AL07HD1030	10/05/88	L.001	L.001	0.012	0.004	0.028	0.016	L.05
		21/06/88	L.001	L.001	L.001	L.001	0.006	0.003	L.05
		19/07/88	L.001	L.001	0.033	0.001	0.08	0.01	L.05
		23/08/88	L.001	L.001	0.001	0.001	0.006	0.006	
		28/09/88	L.001	L.001	0.003	L.001	0.003	0.002	L.05
		13/12/88	L.001	L.001	L.001	L.001	0.003	0.003	L.05
		01/03/89	L.001	L.001	L.001	L.001	0.003	0.002	L.05
Wolverine R.	00AL07HE1000	10/05/88	L.001	L.001	0.019	L.001	0.044	0.026	L.05
		21/06/88	L.001	L.001	0.01	L.001	0.021	0.011	L.05
		19/07/88	L.001	L.001	0.04	0.002	0.074	0.014	L.05
		23/08/88	L.001	L.001	L.001	L.001	0.01	0.006	L.05
		28/09/88	L.001	L.001	0.004	L.001	0.006	0.006	L.05
		13/12/88	L.001	L.001	0.003	L.001	0.006	0.006	L.05
Keg R.	00AL07HF1300	10/05/88	L.001	L.001	0.013	0.002	0.038	0.038	L.05
		21/06/88	0.002	L.001	0.005	L.001	0.016	0.015	L.05
		19/07/88	L.001	L.001	0.021	0.005	0.028	0.014	L.05
		23/08/88	L.001	L.001	0.003	0.001	0.006	0.006	
		28/09/88	L.001	L.001	0.002	L.001	0.004	0.004	L.05
		13/12/88	L.001	L.001	0.002	L.001	0.008	0.007	L.05
		01/03/89	L.001	L.001	L.001	L.001	0.007	0.003	L.05
PR nr La Crete-c	00AL07HF1530	10/05/88	L.001	L.001	0.014	L.001	0.04	0.014	L.05
		21/06/88	L.001	L.001	0.012	L.001	0.027	0.017	L.05
		19/07/88	L.001	L.001	0.039	0.003	0.08	0.024	L.05
		23/08/88	L.001	L.001	L.001	L.001	0.005	0.003	L.05
		28/09/88	L.001	L.001	0.002	L.001	0.003	0.001	L.05
		13/12/88	L.001	L.001	L.001	L.001	0.003	0.003	L.05
		02/03/89	L.001	L.001	0.002	L.001	0.003	0.001	L.05
PR nr Ft. Vermilion-c	00AL07HF1720	11/05/88	L.001	L.001	0.018	L.001	0.034	0.013	L.05
		21/06/88	L.001	L.001	0.017	L.001	0.04	0.012	L.05
		19/07/88	L.001	L.001	0.05	0.004	0.098	0.008	L.05
		23/08/88	L.001	L.001	L.001	L.001	0.01	0.003	L.05
		29/09/88	L.001	L.001	0.001	L.001	0.008	0.007	L.05
		13/12/88	L.001	L.001	0.002	L.001	0.004	0.004	L.05

Appendix V. Continued.

Station	Code	Date D/M/Y	Total Ag mg/L 47005	Diss. Ag mg/L 47102	Total V mg/L 23002	Diss. V mg/L 23102	Total Zn mg/L 30005	Diss. Zn mg/L 30105	Total Hg ug/L 80011
PR nr Ft. Vermilion-c	00AL07HF1720	13/12/88	L.001	L.001	0.001	L.001	0.003	0.003	L.05
		13/12/88	L.001	L.001	L.001	L.001	0.003	0.003	L.05
		02/03/89	L.001	L.001	L.001	L.001	0.003	0.003	L.05
		02/03/89	L.001	L.001	L.001	L.001	0.003	0.002	L.05
		02/03/89	L.001	L.001	L.001	L.001	0.003	0.001	L.05
Ft. Vermilion STP	21AL07HF1000	24/05/88	L.001	L.001	0.005	0.002	0.009	0.004	L.05
Boyer R.	00AL07JF1000	10/05/88	L.001	L.001	0.102	0.006	0.22	0.045	L.05
		21/06/88	L.001	L.001	0.014	L.001	0.04	0.013	L.05
		19/07/88	L.001	L.001	0.016	L.001	0.03	0.017	L.05
		23/08/88	L.001	L.001	0.02	0.002	0.012	0.009	
		29/09/88	L.001	L.001	0.003	0.003	0.003	0.002	L.05
		13/12/88	L.001	L.001	L.001	L.001	0.01	0.01	L.05
		02/03/89	L.001	L.001	0.005	L.001	0.008	0.008	L.05
Wabasca R.	00AL07JD1000	11/05/88	L.001	L.001	0.01	0.004	0.042	0.038	L.05
		21/06/88	L.001	L.001	0.012	L.001	0.022	0.018	L.05
		19/07/88	L.001	L.001	0.036	0.005	0.084	0.022	L.05
		23/08/88	L.001	L.001	0.007	0.002	0.01	0.005	
		29/09/88	L.001	L.001	0.006	0.004	0.007	0.007	L.05
		14/12/88	L.001	L.001	L.001	L.001	0.005	0.003	L.05
		02/03/89	L.001	L.001	L.001	L.001	0.004	0.004	L.05
Nikkwa R.	00AL07JE1000	19/07/88	L.001	L.001	0.01	0.006	0.012	0.006	L.05
		23/08/88	L.001	L.001	0.003	0.002	0.003	0.003	
		14/12/88	L.001	L.001	L.001	L.001	0.003	0.003	L.05
		02/03/89	L.001	L.001	0.002	L.001	0.003	0.003	L.05
Wentzel R.-mouth	00AL07KA1500	11/05/88	L.001	L.001	0.021	0.006	0.032	0.031	L.05
Wentzel R.-Hwy.58	00AL07KA1000	21/06/88	L.001	L.001	0.004	L.001	0.005	0.016	L.05
		19/07/88	L.001	L.001	0.007	L.001	0.106	0.024	L.05
	00AL07KA1500	23/08/88	L.001	L.001	0.007	L.001	0.007	0.005	
		29/09/88	L.001	L.001	0.002	L.001	0.003	0.002	L.05
		14/12/88	L.001	L.001	L.001	L.001	0.003	0.003	L.05
		02/03/89	L.001	L.001	0.001	L.001	0.003	0.003	L.05
PR u/s Wood Buffalo-c	00AL07KA2000	11/05/88	L.001	L.001	0.028	0.002	0.066	0.015	L.05
		21/06/88	L.001	L.001	0.024	L.001	0.056	0.013	L.05
		19/07/88	L.001	L.001	0.049	0.003	0.006	0.004	L.05
		23/08/88	L.001	L.001	0.002	L.001	0.007	0.004	
		29/09/88	L.001	L.001	0.001	0.001	0.007	0.005	L.05
		14/12/88	L.001	L.001	L.001	L.001	0.004	0.004	L.05
		02/03/89	L.001	L.001	L.001	L.001	0.003	0.001	L.05
PR nr Peace Point-c	00AL07KC1000	11/05/88	L.001	L.001	0.03	L.001	0.06	0.022	L.05
		21/06/88	L.001	L.001	0.046	L.001	0.16	0.015	L.05
		19/07/88	L.001	L.001	0.035	0.006	0.078	0.02	L.05
		23/08/88	L.001	L.001	L.001	L.001	0.007	0.002	L.05
		29/09/88	L.001	L.001	0.006	0.005	0.007	0.003	L.05
		14/12/88	L.001	L.001	0.007	L.001	0.013	0.005	L.05
		02/03/89	L.001	L.001	L.001	L.001	0.003	0.002	L.05

Appendix. V. Trace organics detected in Peace River system, May 1988.

	PR at Border	PR at Dunvegan	PR u/s Smoky	Smoky R.	G.P. STP	P&G Effluent	P.R. STP	P.R. Oils #1	PR d/s Daishowa (r)	PR d/s Daishowa (c)	PR d/s Daishowa (l)	PR u/s Whitemud	PR at Manning (r)	PR at Manning (c)	PR at Manning (l)	PR u/s Notikewin	Notikewin R.	PR at Ft. Vermilion	Boyer R.	Wabasca R.
Hydrocarbons (Total)						0.4	6.5	0.32												
EXTRACTABLE 'PRIORITY POLLUTANTS'																				
Acenaphthene						0.X														
Acenaphthylene						0.X	0.X													
Anthracene							1.X	0.X												
Benzoic acid			0.X										0.X	0.X	0.X					
Bis(2-ethylhexyl)-phthalate	0.X	1.X	1	1.X		6	20		1	2	3	1.X	4	2	1	0.X	1.X	1	1	1.X
Butylbenzylphthalate							3													
4-Chloro-3-methyl-phenol						1.X														
2-Chloronaphthalene					0.X			0.X								0.X	0.X		0.X	0.X
2-Chlorophenol						1.X														
Dibutylphthalate	0.X	0.X	0.X	1.X		1.X	4	0.X	0.X	0.X	0.X	1	0.X	0.X	0.X	1	1	2	2	2
2,4-Dichlorophenol						3														
Diethylphthalate	0.X		0.X	0.X			12	0.X				0.X				0.X	0.X	0.X	0.X	0.X
Dimethylphthalate							0.X	1												
Di-n-octylphthalate							1.X						0.X							
2,4-Dimethyl phenol						0.X	1.X	0.X												
2,4-Dinitrotoluene							0.X													
Fluorene							0.X													
Hexadecanoic acid	3.X		2.X			45	1600		3.X	3			14	21					3.X	2.X
Isophorone					0.X		1.X													
Naphthalene							3	0.X												
Nitrobenzene						1.X														
n-Nitroso-di-n-propylamine							1.X													
Phenanthrene							0.X	0.X												
Phenol			0.X		0.X	0.X	10	0.X					0.X							
2,4,5-Trichlorophenol						3														
2,4,6-Trichlorophenol						50														
PURGEABLE 'PRIORITY POLLUTANTS'																				
Benzene								1												
Chloroform				0.X	1.X	28	3	3												
1,4-Dichlorobenzene	0.X					0.X	2													
Ethylbenzene							2													
Toluene	0.X						32													0.X
m,p-Xylene							4													
o-Xylene							4													

Units are ug/L, except for hydrocarbon (mg/L); X - estimated value, rounded to nearest integer.
blank - below analytical detection limit. Only detected compounds are listed.
T - trace amount detected.

Appendix. V. Trace organics - May 1988, Contiued...

	PR at Border	PR at Dunvegan	PR u/s Smoky	Smoky R.	G.P. STP	P&G Effluent	P.R. STP	P.R. Oils #1	PR d/s Daishowa (r)	PR d/s Daishowa (c)	PR d/s Daishowa (l)	PR u/s Whitemud	PR at Manning (r)	PR at Manning (c)	PR at Manning (l)	PR u/s Notikewin	Notikewin R.	PR at Ft. Vermilion	Boyer R.	Vabasca R.
OTHERS																				
Abietic acid						200X														
Caffeine							25X													
2-Chlorobenzoic acid						45X														
Cresol							120X													
Cyclohexenone						27X														
p-Cymen-8-ol						70X														
1,1-Dichlorodimethyl-sulphone						320X														
Dihydrocyclohexadiene						25X														
Dihdyromethyl-cyclohexadiene						25X														
Dihdyromethyl-naphthalenes								2.X												
Dimethoxycyclohexadiene						45X														
2,3-Dimethyl-2-cyclopentenone						30X														
Dimethyl hexadiene						25X														
Dimethyl disulphide						500X														
Dimethyl sulphide						250X														
Dimethyl trisulphide						10X														
Dimethyl sulphone						20X														
Fenchone						25X														
Guaicol						230X														
2-Heptanone-3-propylidene								2.X												
Isopimaric acid						T														
Methylethyl thiophene						80														
4-Methyl-1-(1-methylethyl)-3-cyclohexene-1-ol						62														
Methyl naphthalenes							60X	4.X												
Neoabietic acid						T														
2-Nitrophenol					0.X	1.X	0.X													
Sabinene						25X														
Sulphur (56)								20X												
Sulphur(58)								2.X						2.X						
alpha-Terpineol							10X													
1,2,3,4-Tetrachloro-5,6-veratrole						84X														
Tetrahydronaphthalene							15.X													
1-(2-Thienyl)thiophene						30X														
m-Toluic acid						T														
3,4,5-Trichloroveratrole						55X														
2,3,4-Trimethyl-2-cyclopentene-1-one						115X														
Trimethyl-2-cyclopentene-1-one						115X														
Veratrole						60X														

Units are ug/L, except for hydrocarbon (mg/L); X - estimated value, rounded to nearest integer.
blank - below analytical detection limit. Only detected compounds are listed.
T - trace amount detected.

Appendix. V. Trace organics detected in the Peace River system, August 1988.

	PR at Border	PR at Dunvegan	PR u/s Smoky	Smoky R.	PEG Effluent	P.R. STP	P.R. Oils #1	PR u/s Whitemud	PR u/s Notikewin	Notikewin R.	PR at Ft. Vermilion	Boyer R.	Wabasca R.
Hydrocarbons (Total)													
EXTRACTABLE 'PRIORITY POLLUTANTS'													
Benzoic acid					13	52							
Bis(2-chloroethoxyl)-methane						1.X							
Bis(2-ethylhexyl)-phthalate	2	3	1	1.X	2	23	1	1	2	1	2	1	1
Butylbenzylphthalate						3							
2-Chlorophenol					2.X								
Dibutylphthalate	1.X	1.X	1.X	1.X	1.X	5	1.X	1.X	1.X	0.X	1.X	1.X	1.X
2,4-Dichlorophenol					2								
Diethylphthalate						12							
2,4-Dimethyl phenol					1.X	2.X							
Fluorene						1.X							
Hexadecanoic acid	11	7	6		94	275		11	11		7	7	5
Isophorone					1	1.X							
Naphthalene					3	10	0.X						
Nitrobenzene					4								
Phenanthrene						1							
Phenol						10							
2,4,6-Trichloropheol					9								
PURGEABLE 'PRIORITY POLLUTANTS'													
Benzene					0.X	1.X	0.X	0.X			0.X		
2-Chloroethoxyethylene						2.X							
Chloroform					42	4							
1,2-Dichlorobenzene						0.X							
1,3-Dichlorobenzene						2							
1,4-Dichlorobenzene						2							
Ethylbenzene						1.X							
Tetrachloroethylene						6							
Toluene						31		1.X	0.X		0.X		0.X
1,1,1-Trichloroethane						0.X							
m,p-Xylene						6							
o-Xylene						6							

Units are ug/L, except for hydrocarbon (mg/L); X - estimated value, rounded to nearest integer. blank - below analytical detection limit. Only detected compounds are listed.

Appendix. V. Trace organics detected in the Peace River system, August 1988.

	PR at Border	PR at Dunvegan	PR u/s Smoky	Smoky R.	P&G Effluent	P.R. STP	P.R. Oils #1	PR u/s Whitemud	PR u/s Notikewin	Notikewin R.	PR at Ft. Vermilion	Boyer R.	Wabasca R.
OTHERS													
Benzenacetic acid						200X							
Benzenepropanoic acid						40X							
Cyclohexenone					25X								
p-Cymen-8-ol					250X								
1,1-Dichlorodimethyl-sulphone					140X								
Dimethoxybenzene						10X							
Dimethyl cyclopentenone					60X								
Dimethyl disulphide					200X								
Dimethyl trisulphide					20X								
Guaicol					120X								
4-Methylphenol					200X	20X							
Methylethyl thiophene					30X								
Methyl-5-methyl-2-thiophene carboxylate					30X								
n-Nitrosodiphenylamine						0.X							
Sandaracopimaric acid					200X								
Stearic acid						20X							
3,4,5-Trichloroguaiacol					25X								
2,3,4-Trimethyl-2-cyclopentene-1-one					60X								
Trimethyl-2-cyclopentene-1-one					50X								

Units are ug/L, except for hydrocarbon (mg/L); X - estimated value, rounded to nearest integer.
blank - below analytical detection limit.

Appendix. V. Trace organics detected in the Peace River system, October 1988.

	PR Oils #1	PR d/s Daishowa (right)	PR d/s Daishowa (centre)	PR d/s Daishowa (left)
Hydrocarbons (Total)	0.57			
EXTRACTABLE 'PRIORITY POLLUTANTS'				
Benzoic acid		0.X		
Bis(2-ethylhexyl)-phthalate	1	1.X	1	2
Dibutylphthalate	1.X	1.X	0.X	0.X
Hexadecanoic acid		2.X		
Naphthalene	0.X			
PURGEABLE 'PRIORITY POLLUTANTS'				
Benzene	0.X			
OTHERS				
n-Nitrosodiphenylamine	0.X			

Units are ug/L, except for hydrocarbon (mg/L)
X - estimated value, rounded to nearest integer.
blank - below analytical detection limit.

Appendix. V. Trace organics detected in the Peace River system, Feb.-March 1989.

	PR at Border	PR at Dunvegan	PR u/s Smoky	Smoky R.	P.R. STP	PR u/s Whitemud	PR u/s Notikewin	Notikewin R.
Hydrocarbons (Total)					6.0			
SEMI-VOLATILES								
Benzoic acid		1.X			31		1.X	1.X
Bis(2-ethylhexyl)-phthalate	1.X	2	3	1	13	1	1.X	9
Butylbenzylphthalate								1.X
Dibutylphthalate			0.X		1			0.X
Hexadecanoic acid					167			2.X
Naphthalene					7			
Phenol					8			
VOLATILES								
Benzene		0.X			0.X			
Chloroform				0.X	5			
1,2-Dichlorobenzene					1			
1,2-Dichloroethane					0.X			
Ethylbenzene					2			
Tetrachloroethylene					8			
Toluene		1.X			8			
1,1,1-Trichloroethane					1			
Trichloroethylene					1.X			
m,p-Xylene		0.X			9			
o-Xylene					7			
OTHERS								
Benzenacetic acid						200X		
Benzenepropanoic acid						40X		
Cyclohexenone					25			
p-Cymen-8-ol					250			
1,1-Dichlorodimethyl-sulphone					140			
Dimethoxybenzene						10X		
Dimethyl cyclopentenone					60			
Dimethyl disulphide					200X			
Dimethyl trisulphide					20X			
Guaicol					120			
4-Methylphenol					200	20X		
Methylethyl thiophene					30			
Methyl-5-methyl-2-thiophene carboxylate					30			
n-Nitrosodiphenylamine						0.X		
Sandaracopimaric acid					200			
Stearic acid						20X		
3,4,5-Trichloroguaiacol					25			
2,3,4-Trimethyl-2-cyclopentene-1-one					60			
Trimethyl-2-cyclopentene-1-one					50			

Units are ug/L, except for hydrocarbon (mg/L); X - estimated value, rounded to nearest integer.
blank - below analytical detection limit.

Appendix VI. NAQUADAT summary report for the Peace River at Dunvegan, 1969-89.

	SUBH ID	00201L TOTAL DISSOLVED SOLIDS MG/L	02011L COLOUR APPARENT REL. UNITS	02021L COLOUR TRUE REL. UNITS	02041F SPECIFIC CONDUCT. US/CM	02041L SPECIFIC CONDUCT. US/CM	02061F TEMPERATURE OF WATER DEG.C	02071L TURBIDITY JTU	02074L TURBIDITY NTU
SAMPLES(FLAGS)	0056	78(1)	45(2)	103(13)	126(0)	145(0)	148(0)	113(0)	44(0)
LOW	0103	80.	L5.	L5.0	100.	156.0	.0	1.	1.1
HIGH	0003	169.	500.	150.0	300.0	376.0	22.8	800.	596.0
AVERAGE	0479	112.*	50.*	22.9*	194.4	205.7	7.0	50.6	80.1
STD.DEV.	0001	13.*	81.*	28.7*	30.7	26.9	6.7	99.9	133.0
PERCNT:10TH	0311	101.	5.	L5.0	162.	182.0	.0	2.2	2.8
25TH		104.	10.	7.5	174.0	191.0	.0	4.0	4.2
MEDIAN 50TH		110.	30.	10.0	190.0	198.0	5.5	10.0	11.4
75TH		116.	60.	25.0	211.0	214.	13.0	53.0	92.5
90TH		128.	120.	55.0	230.0	232.0	17.0	130.	302.0
SECONDARY CODE					41S		61S	73L	81L

	SUBH ID	06001L CARBON TOTAL ORGANIC C MG/L	06051L CARBON TOTAL INORGANIC C MG/L	06101L CARBON DISSOLVED ORGANIC C MG/L	06151L CARBON DISSOLVED INORGANIC C MG/L	06901L CARBON ORGANIC PARTICUL. C MG/L	06201L BICARBONT. (CALCD.) HCO3 MG/L	06202L BICARBONT. (CALCD.) HCO3 MG/L	06301L CARBONATE (CALCD.) CO3 MG/L
SAMPLES(FLAGS)	0056	11(0)	11(0)	143(0)	28(0)	138(0)	76(0)	85(0)	76(0)
LOW	0103	1.	10.0	1.	14.	.1	86.5	86.5	.0
HIGH	0003	22.0	23.	13.0	23.	43.1	135.3	148.7	.5
AVERAGE	0479	7.5	18.5	3.59	19.32	2.1	109.2	110.6	.0
STD.DEV.	0001	7.4	4.3	2.13	2.23	5.1	10.6	10.3	.1
PERCNT:10TH	0311	2.	14.0	2.00	14.00	.1	95.1	96.8	.0
25TH		2.	14.	2.4	18.50	.2	102.3	104.1	.0
MEDIAN 50TH		4.	20.	3.	20.00	.4	110.1	110.6	.0
75TH		13.0	22.0	4.00	21.00	1.7	115.8	116.0	.0
90TH		20.0	22.	6.10	21.	5.8	121.9	121.9	.0
SECONDARY CODE				04L	52L	02L			

	SUBH ID	06302L CARBONATE DISSOLVED CO3 MG/L	06401L FREE CO2 (CALCD.) CO2 MG/L	06535L PHENOLIC MATERIAL PHENOL MG/L	06711L CHLORO - PHYLL A MG/L	07001L NITROGEN TOTAL KJELDAHL N MG/L	07105L NITROGEN DISSOLVED NO3 & NO2 N MG/L	07110L NITROGEN DISSOLVED NO3 & NO2 N MG/L	07501L NITROGEN TOTAL AMMONIA N MG/L
SAMPLES(FLAGS)	0056	85(0)	78(0)	34(9)	3(0)	10(2)	5(1)	144(12)	64(63)
LOW	0103	.0	.7	L.001	.016	L.1	L.005	L.01	L.1
HIGH	0003	.6	4.3	.007	.095	2.1	.090	.254	L0.
AVERAGE	0479	.0	1.5	.002*	.043	.710*	.055*	.047*	.116*
STD.DEV.	0001	.1	.7	.002*	.045	.599*	.040*	.033*	.113*
PERCNT:10TH	0311	.0	.9	L.001		.150*		.01	L.1
25TH		.0	1.1	L.001		.3	.020	.020	L.100
MEDIAN 50TH		.0	1.4	.002	.018	.500*	.070	.050	L.100
75TH		.0	1.8	.002		.9	.090	.060	L.100
90TH		.0	2.3	.004		1.650		.070	L.100
SECONDARY CODE						02L	06L		06L

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

		07506P NITROGEN TOTAL AMMONIA	07540L NITROGEN DISSOLVED AMMONIA	07651L NITROGEN DISSOLVED	07901L NITROGEN PARTICUL.	08101F OXYGEN DISSOLVED DO	08101L OXYGEN DISSOLVED DO	09105L FLUORIDE DISSOLVED	10101L ALKALINITY TOTAL
	SUBM	N	N	N	N	O2	O2	F	CACO3
	ID	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
SAMPLES(FLAGS)	0056	101(98)	2(1)	139(0)	138(17)	36(0)	110(0)	129(26)	128(0)
LOW	0103	L.050	L.005	.050	L.010	9.0	8.70	.0	71.0
HIGH	0003	.200	.007	.579	3.9	15.1	16.10	.1	122.0
AVERAGE	0479	.089*	.006*	.144	.197*	11.68	12.08	.1*	89.9
STD.DEV.	0001	.026*	.001*	.081	.462*	1.70	1.64	.0*	8.6
PERCNT:10TH	0311	L.050		.082	L.010	9.4	9.90	L.0	78.0
25TH		.060		.098	.029	10.25	10.80	.1	84.8
MEDIAN 50TH		L.100	.006*	.116	.050	11.70	12.10	.1	90.0
75TH		L.100		.160	.16	12.80	13.40	.1	95.1
90TH		L.100		.24	.49	14.3	14.25	.1	100.0
SECONDARY CODE					02L	01S 01P		08L 06L	06L 11L

		10151L ALKALINITY PHENOL PHTHALEIN	10301F PH	10301L PH	10401L RESIDUE NONFILTR.	10602L HARDNESS TOTAL (CALCD.)	10603L HARDNESS TOTAL	11101L SODIUM DISSOLVED	12101L MAGNESIUM DISSOLVED (CALCD.)
	SUBM	CACO3				CACO3	CACO3	NA	MG
	ID	MG/L	PH UNITS	PH UNITS	MG/L	MG/L	MG/L	MG/L	MG/L
SAMPLES(FLAGS)	0056	128(0)	130(0)	145(0)	144(7)	130(0)	91(0)	135(0)	91(0)
LOW	0103	.0	7.40	7.45	L1.	26.2	85.0	1.0	4.9
HIGH	0003	.4	8.9	8.40	1605.	172.8	172.8	8.3	11.9
AVERAGE	0479	.0			118.*	101.3	103.9	2.1	6.8
STD.DEV.	0001	.0			277.*	12.1	12.7	1.0	1.0
PERCNT:10TH	0311	.0	7.70	7.80	1.	91.0	93.7	1.5	5.8
25TH		.0	7.90	7.90	6.	95.3	96.5	1.6	6.2
MEDIAN 50TH		.0	8.10	8.05	14.	100.2	100.6	1.8	6.6
75TH		.0	8.30	8.2	78.	105.9	109.1	2.2	7.2
90TH		.0	8.45	8.25	353.	112.1	115.3	3.0	7.8
SECONDARY CODE			01S				05L	03L	

		12102L MAGNESIUM DISSOLVED	14101L SILICA REACTIVE	15103L PHOSPHORUS DISSOLVED	15255L PHOSPHORUS DISSOLVED ORTHO PO4	15406L PHOSPHORUS TOTAL	15901L PHOSPHORUS PARTICULATE (CALCD.)	16301L SULPHATE DISSOLVED	17201L CHLORIDE DISSOLVED
	SUBM	MG	SIO2	P	P	P	P	SO4	CL
	ID	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
SAMPLES(FLAGS)	0056	130(0)	131(0)	137(36)	1[illegible](14)	146(0)	135(36)	135(0)	4(0)
LOW	0103	5.3	2.8	L.003	L.002	.003	.000	7.6	.5
HIGH	0003	11.9	8.6	.110	.013	2.1	2.040	65.6	1.2
AVERAGE	0479	6.7	3.8	.010*	.004*	.116	.107*	12.9	.73
STD.DEV.	0001	.8	.6	.015*	.003*	.242	.241*	6.7	.32
PERCNT:10TH	0311	5.8	3.2	L.003	L.003	.007	.003	9.4	
25TH		6.1	3.4	L.003	L.003	.011	Q.008	10.0	.55
MEDIAN 50TH		6.5	3.8	.005	L.003	.027	.022	11.0	.60
75TH		7.0	4.2	.010	.003	.110	.095	13.0	.90
90TH		7.7	4.4	.018	.008	.260	.245	16.7	
SECONDARY CODE			02L 05L		57L 56L	13L		03L 04L 06L	03L

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

		17206L CHLORIDE DISSOLVED	19101L POTASSIUM DISSOLVED	20101L CALCIUM DISSOLVED	20103L CALCIUM DISSOLVED	03301L LITHIUM EXTRBLE.	05105L BORON DISSOLVED	13302L ALUMINUM EXTRBLE.	13303L ALUMINUM EXTRBLE.
	SUBM ID	CL MG/L	K MG/L	CA MG/L	CA MG/L	LI MG/L	B MG/L	AL MG/L	AL MG/L
SAMPLES(FLAGS)	0056	131(0)	135(1)	5(0)	130(0)	15(12)	127(3)	11(1)	6(0)
LOW	0103	.30	L.1	30.0	.3	L.005	L.02	L.10	.024
HIGH	0003	3.00	3.80	44.0	49.6	.021	.600	7.9	.23
AVERAGE	0479	.80	.63*	37.7	29.6	.007*	.061*	1.6782*	.0758
STD.DEV.	0001	.33	.50*	6.2	3.8	.005*	.068*	2.3457*	.0810
PERCNT:10TH	0311	.6	.4		26.8	L.005	.030	.12	
25TH		.7	.42	32.3	28.0	L.005	.040	.31	.025
MEDIAN 50TH		.70	.50	40.0	29.5	L.005	.05	.70	.0380
75TH		.80	.60	42.0	30.8	L.005	.060	2.9	.10
90TH		1.00	.90		32.8	.018	.080	3.5	
SECONDARY CODE			03L			01P		02P	05P

		23002L VANADIUM TOTAL	23020L VANADIUM TOTAL RECOVERABLE	23301L VANADIUM EXTRBLE.	24302L CHROMIUM EXTRBLE.	25303L MANGANESE EXTRBLE.	26304L IRON EXTRBLE.	27002L COBALT TOTAL	27020L COBALT TOTAL RECOVERABLE
	SUBM ID	V MG/L	VA MG/L	V MG/L	CR MG/L	MN MG/L	FE MG/L	CO MG/L	CO MG/L
SAMPLES(FLAGS)	0103	24(8)	15(7)	14(11)	19(18)	50(16)	51(0)	24(13)	15(13)
LOW	0003	L.000	.001	L.001	L.010	L.002	.060	L.000	L.001
HIGH	0479	.015	.011	L.05	.033	.97	27.	.008	.007
AVERAGE	0001	.003*	.003*	.022*	.0133*	.071*	1.879	.001*	.002*
STD.DEV.		.004*	.003*	.025*	.0054*	.153*	4.509	.001*	.001*
PERCNT:10TH		L.000	L.001	L.001	L.010	.008	.08	L.000	L.001
25TH		L.000	L.001	L.001	L.010	L.01	.107	.001*	L.002
MEDIAN 50TH		.001	L.001	.003	L.010	L.020	.315	L.001	L.002
75TH		.003	.002	L.05	L.015	.060	1.600	.001	L.002
90TH		.009	.010	L.05	L.0150	.170	4.700	.003	.004
SECONDARY CODE		02P	20P	01P 02P	02P	04P 04L	04P	02P	20P

		27301L COBALT EXTRBLE.	28002L NICKEL TOTAL	28020L NICKEL TOTAL RECOVERABLE	28301L NICKEL EXTRBLE.	29005L COPPER TOTAL	29020L COPPER TOTAL RECOVERABLE	29305L COPPER EXTRBLE.	30005L ZINC TOTAL
	SUBM ID	CO MG/L	NI MG/L	NI MG/L	NI MG/L	CU MG/L	CU MG/L	CU MG/L	ZN MG/L
SAMPLES(FLAGS)	0056	19(12)	24(2)	14(6)	19(11)	24(2)	15(4)	20(6)	24(1)
LOW	0103	L.001	.001	.001	L.001	L.001	L.001	L.001	L.001
HIGH	0003	.017	.026	.014	.060	.022	.008	.046	.078
AVERAGE	0479	.005*	.004*	.004*	.010*	.004*	.003*	.008*	.010*
STD.DEV.	0001	.005*	.005*	.004*	.015*	.005*	.002*	.011*	.016*
PERCNT:10TH		L.001	.001	.001	L.001	.001	L.001	L.001	.001
25TH		L.002	.001*	L.002	L.002	.001	L.001	.001*	.002
MEDIAN 50TH		L.002	.002	L.002	.005	.002	.002	.003	.004
75TH		L.01	.004	.004	L.01	.005	.004	.012	.013
90TH		.015	.006	.011	.029	.009	.007	.022	.016
SECONDARY CODE		01P 02P	02P	20P	01P 02P	05P	20P	06L 05P 06P	05P

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

	SUBM ID	30020L ZINC TOTAL RECOVERABLE ZN MG/L	30305L ZINC EXTRBLE. ZN MG/L	33102L ARSENIC DISSOLVED AS MG/L	33104L ARSENIC DISSOLVED AS MG/L	33108L ARSENIC DISSOLVED AS MG/L	34102L SELENIUM DISSOLVED SE MG/L	38301L STRONTIUM EXTRBLE. SR MG/L	42301L MOLYBDENUM EXTRBLE. MO MG/L
SAMPLES(FLAGS)	0103	14(1)	17(0)	5(2)	53(45)	63(3)	111(50)	19(0)	18(18)
LOW	0003	L.001	.001	L.005	L.0005	L.0001	L.0001	.05	L.05
HIGH	0479	.031	.046	.015	.0014	.0014	.0006	.25	L.100
AVERAGE	0001	.009*	.010	.0086*	.0005*	.0003*	.0004*	.138	
STD.DEV.	0311	.010*	.013	.0046*	.0001*	.0002*	.0001*	.054	
PERCNT:10TH		.002	.001		L.0005	.0001	.0002	.07	L.05
25TH		.003	.002	L.005	L.0005	.0002	.0003	.11	L.05
MEDIAN 50TH		.005	.004	.006	L.0005	.0002	.0004	.13	L.075
75TH		.016	.018	.012	L.0005	.0003	L.0005	.16	L.10
90TH		.029	.031		.0005	.0005	L.0005	.24	L.10
SECONDARY CODE		20P	05P	03L			08L	01P	01P

	SUBM ID	47301L SILVER EXTRBLE. AG MG/L	48002L CADMIUM TOTAL CD MG/L	48020L CADMIUM TOTAL RECOVERABLE CD MG/L	48301L CADMIUM EXTRBLE. CD MG/L	51301L ANTIMONY EXTRBLE. SB MG/L	56001L BARIUM TOTAL BA MG/L	56020L BARIUM TOTAL RECOVERABLE BA MG/L	56301L BARIUM EXTRBLE. BA MG/L
SAMPLES(FLAGS)	0103	48(47)	24(16)	15(13)	19(16)	5(5)	24(16)	15(5)	19(13)
LOW	0003	L.004	L.000	L.001	L.001	L.008	L.080	L.050	L.05
HIGH	0479	L.01	L.001	.001	L.01	L.50	.327	.16	.54
AVERAGE	0001	.005*	.001*	.001*	.002*		.112*	.085*	.125*
STD.DEV.		.002*	.000*	.000*	.003*		.052*	.041*	.125*
PERCNT:10TH		L.004	L.000	L.001	L.001		L.080	L.050	L.05
25TH		L.004	.000	L.001	L.001	L.20	L.080	L.050	L.05
MEDIAN 50TH		L.004	L.001	L.001	L.001	L.40	L.100	.060	L.1
75TH		L.005	L.001	L.001	.001	L.40	.115	.120	.1
90TH		L.01	L.001	.001	L.01		.160	.150	.3
SECONDARY CODE		01P	02P	20P	01P 02P	01P 02P	01P	20P	01P

	SUBM ID	80011L MERCURY TOTAL HG UG/L	80311L MERCURY EXTRBLE. HG UG/L	81301L THALLIUM EXTRBLE. TL MG/L	82002L LEAD TOTAL PB MG/L	82020L LEAD TOTAL RECOVERABLE PB MG/L	82301L LEAD EXTRBLE. PB MG/L	36001L COLIFORMS TOTAL MPN NO/100ML	36011L COLIFORMS FECAL MPN NO/100ML
SAMPLES(FLAGS)	0056	22(4)	16(12)	6(6)	24(10)	15(12)	19(14)	133(11)	134(58)
LOW	0103	L.02	L.02	L.10	L.0007	L.001	L.001	1.	L1.
HIGH	0003	.150	.060	L.2	.0640	.064	.019	1600.	116.
AVERAGE	0479	.053*	.035*		.0044*	.008*	.0048*	105.*	11.*
STD.DEV.	0001	.039*	.015*		.0128*	.016*	.0042*	235.*	20.*
PERCNT:10TH	0311	L.020	L.02		.0008	L.004	L.001	4.	L2.
25TH		.020	L.020	L.10	L.0010	L.004	L.001	12.	L2.
MEDIAN 50TH		.045	.030	L.200	.0010*	L.004	L.004	35.	L4.
75TH		.06	L.050	L.2	.0021	L.004	.006	100.	8.
90TH		.120	L.05		.0040	.014	L.01	220.	24.
SECONDARY CODE		11P	11P 13P	01P 02P	02P	20P	02P	02L 02F 01F	12L 12F 11F

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

	SUBN ID	36101L STREP. FECAL	36103L FECAL STREP.	17811L HEXACHLORO-BENZENE	18000L P,P-DDT	18005L O,P-DDT	18010L P,P-DDD	18020L P,P-DDE	18030L P,P-METHOXY-CHLOR
			HF						
			NO/DL	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
SAMPLES(FLAGS)	0103	73(31)	81(21)	42(42)	48(48)	42(42)	48(48)	48(48)	48(48)
LOW	0479	L2.	L2.	L.001	L.004	L.001	L.001	L.001	L.01
HIGH	0001	368.	368.	L.001	L.004	L.001	L.002	L.001	L.012
AVERAGE	0311	27.*	46.*						
STD.DEV.	0003	61.*	83.*						
PERCNT:10TH		L2.	2.	L.001	L.004	L.001	L.002	L.001	L.01
25TH		L2.	L4.	L.001	L.004	L.001	L.002	L.001	L.010
MEDIAN 50TH		2.	12.	L.001	L.004	L.001	L.002	L.001	L.010
75TH		20.	44.	L.001	L.004	L.001	L.002	L.001	L.010
90TH		76.	80.	L.001	L.004	L.001	L.002	L.001	L.010
SECONDARY CODE		02L 02F	03F						

	SUBN ID	18040L HEPTACHLOR	18045L HEPTACHLOR EPOXIDE	18050L ALPHA-ENDO-SULFHAN	18055L BETA-ENDO-SULFHAN	18060L ALPHA-CHLORDANE	18065L GAMMA-CHLORDANE	18070L GAMMA-BHC (LINDANE)	18075L ALPHA-BHC
		UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
SAMPLES(FLAGS)	0103	48(48)	48(48)	48(48)	48(48)	44(44)	44(44)	48(45)	44(8)
LOW	0479	L.001	L.002	L.001	L.003	L.003	L.002	L.001	L.001
HIGH	0001	L.001	L.002	L.001	L.003	L.003	L.002	.001	.008
AVERAGE	0003							.001*	.003*
STD.DEV.								.000*	.002*
PERCNT:10TH		L.001	L.002	L.001	L.003	L.003	L.002	L.001	L.001
25TH		L.001	L.002	L.001	L.003	L.003	L.002	L.001	.001
MEDIAN 50TH		L.001	L.002	L.001	L.003	L.003	L.002	L.001	.002
75TH		L.001	L.002	L.001	L.003	L.003	L.002	L.001	.004
90TH		L.001	L.002	L.001	L.003	L.003	L.002	L.001	.005
SECONDARY CODE									

	SUBN ID	18125L MIREX TOTAL	18130L ALDRIN	18140L ENDRIN	18150L DIELDRIN	18159L AROCLOR 1242 (PCB'S)	18160L AROCLOR 1254 (PCB'S)	18161L AROCLOR 1248 (PCB'S)	18162L AROCLOR 1260 (PCB'S)
		UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
SAMPLES(FLAGS)	0103	42(42)	47(47)	44(44)	48(48)	9(9)	24(24)	15(15)	22(22)
LOW	0003	L.001	L.001	L.002	L.002	L.002	L.002	L.002	L.005
HIGH	0479	L.001	L.001	L.002	L.002	L.002	L.032	L.024	L.06
AVERAGE	0001								
STD.DEV.									
PERCNT:10TH		L.001	L.001	L.002	L.002		L.002	L.002	L.005
25TH		L.001	L.001	L.002	L.002	L.002	L.002	L.002	L.005
MEDIAN 50TH		L.001	L.001	L.002	L.002	L.002	L.002	L.002	L.005
75TH		L.001	L.001	L.002	L.002	L.002	L.002	L.002	L.005
90TH		L.001	L.001	L.002	L.002		L.002	L.02	L.005
SECONDARY CODE									

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

	SUBM ID	18164L ARCCLORS TOTAL (PCB'S)	18190L GUTHION	18195L AZIN-PHOSETHYL	18205L IMIDAN	18215L DISULFOTON	18230L CRUFOMATE	18240L PARTHION	18245L PARATHION-METHYL
		UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
SAMPLES(FLAGS)	0479	35(35)	39(39)	33(33)	33(33)	33(33)	34(34)	40(40)	35(35)
LOW	0001	L.002	L.1	L.2	L.2	L.02	L.2	L.01	L.01
HIGH	0003	L.020	L.500	L.200	L.200	L.020	L.200	L.020	L.020
AVERAGE									
STD.DEV.									
PERCNT:10TH		L.002	L.1	L.200	L.200	L.020	L.200	L.010	L.020
25TH		L.002	L.500	L.20	L.20	L.020	L.20	L.020	L.02
MEDIAN 50TH		L.002	L.500	L.200	L.200	L.020	L.200	L.020	L.020
75TH		L.002	L.500	L.200	L.200	L.020	L.200	L.020	L.020
90TH		L.002	L.500	L.200	L.200	L.020	L.200	L.020	L.020
SECONDARY CODE			90P	95P	05P	15P	30P	40P	45P

	SUBM ID	18250L MALATHION	18260L FENCHLORPHOS (RONNEL)	18270L DIAZIONON	18300L PHORATE	18310L ETHION	18320L CARBO-PHENOTHION	18325L METHYLCARBO-PHENOTHION	18500L 2,4-D
		UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
SAMPLES(FLAGS)	0103	39(39)	34(34)	38(38)	33(33)	39(38)	39(39)	1(1)	39(37)
LOW	0479	L.01	L.02	L.02	L.02	L.01	L.02	L.02	L.004
HIGH	0001	L.050	L.020	L.020	L.0200	L.0200	L.0200	L.02	.05
AVERAGE						.0187*			.005*
STD.DEV.						.0034*			.007*
PERCNT:10TH		L.01	L.020	L.02	L.0200	L.01	L.02		L.004
25TH		L.050	L.02	L.020	L.02	L.0200	L.0200		L.004
MEDIAN 50TH		L.050	L.020	L.020	L.0200	L.0200	L.0200		L.004
75TH		L.050	L.020	L.020	L.0200	L.0200	L.0200		L.004
90TH		L.050	L.020	L.020	L.0200	L.0200	L.0200		L.004
SECONDARY CODE		50P	60P	70P	00P	10P	20P		00P

	SUBM ID	18503L 2,4-D	18510L 2,4,5-T	18513L 2,4,5-T METHYL ESTER	18516L 2,4,-DP	18520L MCPA	18523L MCPA	18524L MCPB	18530L DIACAMBA
		UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
SAMPLES(FLAGS)	0103	5(5)	39(37)	5(5)	5(5)	37(37)	7(7)	7(7)	6(6)
LOW	0479	L.030	L.001	L.050	L.030	L.2	L.030	L.050	L.030
HIGH	0001	L.030	.009	L.050	L.030	L.200	L.030	L.050	L.030
AVERAGE	0003		.002*						
STD.DEV.			.001*						
PERCNT:10TH			L.002			L.2			
25TH		L.030	L.002	L.050	L.030	L.200	L.030	L.050	L.03[illegible]
MEDIAN 50TH		L.030	L.002	L.050	L.030	L.200	L.030	L.050	L.030
75TH		L.030	L.002	L.050	L.030	L.200	L.030	L.050	L.030
90TH			L.002			L.200			
SECONDARY CODE		03P	10P	13P	16P	20P	23P	24P	30P

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

	SUBM ID	18535L 2,3,6,-TBA	18540L SILVEX	18541L FENOPROP (SILVEX)	18549L 2,4,-DB	18550L 2,4-DB	18555L 2,4-DP	18599L PICLORAM	18601L PICLORAM
		UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
SAMPLES(FLAGS)	0103	7(7)	34(34)	7(7)	7(7)	38(38)	38(37)	6(6)	11(11)
LOW	0479	L.030	L.004	L.030	L.050	L.006	L.002	L.050	L.2
HIGH	0001	L.030	L.004	L.030	L.050	L.009	.004	L.050	L.200
AVERAGE	0003						.004*		
STD.DEV.							.000*		
PERCNT:10TH			L.004			L.009	L.004		L.2
25TH		L.030	L.004	L.030	L.050	L.009	L.004	L.050	L.2
MEDIAN 50TH		L.030	L.004	L.030	L.050	L.009	L.004	L.050	L.2
75TH		L.030	L.004	L.030	L.050	L.009	L.004	L.050	L.200
90TH			L.004			L.009	L.004		L.200
SECONDARY CODE		35P	40P	41P	49P	50P	55P	99P	01P

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

Appendix VII. Mass loads for 1988-1989 synoptic surveys.

Station	Total Alk.	Total Hard.	Ca	Mg	Na	K	HCO3	Cl	SO4	F	React. Silica	BOD	Susp. Solid	Filt. Residue
PR nr border	1.4E+07	1.5E+07	4.7E+06	1.0E+06	3.0E+05	3.3E+06	1.7E+07	2.2E+05	1.6E+06	1.2E+04	7.1E+05	1.1E+05	6.7E+06	1.7E+07
Pouce Coupe R.	7.2E+04	9.0E+04	2.2E+04	8.5E+03	1.9E+04	1.4E+03	8.7E+04	3.9E+03	5.3E+04	5.4E+01	1.1E+03	2.7E+02	1.7E+04	1.5E+05
PR nr Dunvegan	1.2E+07	1.3E+07	3.9E+06	8.8E+05	3.3E+05	1.1E+05	1.4E+07	2.0E+05	1.8E+06	8.1E+03	5.2E+05	5.2E+04	1.9E+07	1.5E+07
P.R.Corr.Inst. STP	1.4E+01	4.7E+01	1.4E+01	3.1E+00	9.1E+00	1.8E+00	1.7E+01	1.1E+01	2.9E+01	1.3E-01	6.3E-01	8.3E-01	1.6E+00	7.9E+01
PR u/s Smoky R.	1.1E+07	1.3E+07	3.9E+06	8.4E+05	2.6E+05	8.5E+04	1.4E+07	4.7E+05	1.4E+06	8.2E+03	5.8E+05	7.9E+04	2.3E+07	1.4E+07
Smoky R.	2.4E+06	3.1E+06	8.9E+05	2.1E+05	2.4E+05	1.7E+04	2.9E+06	2.1E+05	8.0E+05	1.9E+03	6.6E+04	1.1E+04	1.4E+06	3.8E+06
Grande Prairie STP	6.9E+02	7.3E+02	2.0E+02	6.0E+01	3.5E+02	4.0E+01	8.2E+02	4.0E+02	3.2E+02	3.0E+00	2.7E+01	3.4E+01	4.7E+01	1.8E+03
P&G Effluent-grab	1.6E+04	5.1E+04	1.9E+04	9.5E+02	4.9E+04	1.2E+03	2.0E+04	7.0E+04	4.1E+04	9.5E+00	6.6E+02	3.7E+03	1.1E+04	1.8E+05
Peace River STP	5.9E+02	4.2E+02	1.1E+02	3.6E+01	1.7E+02	2.5E+01	7.2E+02	1.0E+02	2.1E+02	2.0E+00	2.7E+01	2.5E+02	7.1E+01	1.1E+03
Peace River Oils	1.0E+04	2.6E+03	2.7E+02	4.7E+02	4.2E+04	5.6E+02	1.0E+04	6.1E+04	3.6E+02	6.4E+00	1.6E+01	0.0E+00	8.8E+01	1.1E+05
PR u/s Whitemud R.	1.4E+07	1.5E+07	4.5E+06	1.0E+06	5.2E+05	9.2E+04	1.6E+07	4.8E+05	1.9E+06	8.2E+03	6.2E+05	1.1E+05	1.2E+07	1.7E+07
Whitemud R.	1.0E+05	1.5E+05	4.3E+04	1.2E+04	1.6E+04	1.5E+03	1.2E+05	6.2E+03	8.0E+04	1.3E+02	4.6E+03	7.7E+02	2.2E+05	2.2E+05
Cadotte R.	1.0E+05	1.2E+05	3.4E+04	8.1E+03	1.2E+04	1.4E+03	1.2E+05	6.3E+03	3.0E+04	9.2E+01	3.4E+03	1.2E+03	1.2E+05	1.5E+05
PR u/s Notikewin R.	1.4E+07	1.6E+07	4.8E+06	1.1E+06	5.2E+05	1.2E+05	1.7E+07	4.8E+05	2.1E+06	1.4E+04	6.9E+05	1.3E+05	2.0E+07	1.8E+07
Notikewin R.	4.6E+05	6.2E+05	1.7E+05	4.6E+04	7.9E+04	6.5E+03	5.6E+05	2.1E+04	2.9E+05	4.9E+02	2.5E+04	4.6E+03	5.3E+05	8.9E+05
Wolverine R.	2.1E+05	2.6E+05	7.4E+04	1.8E+04	1.5E+04	3.0E+03	2.6E+05	4.7E+03	6.3E+04	1.8E+02	3.4E+03	4.1E+03	3.7E+05	3.1E+05
Keg R.	1.0E+05	1.2E+05	3.5E+04	8.5E+03	1.3E+04	1.8E+03	1.2E+05	3.7E+03	4.1E+04	1.1E+02	3.9E+03	4.6E+02	6.7E+04	1.7E+05
PR nr Ft. Vermilion	1.7E+07	2.1E+07	5.9E+06	1.4E+06	9.2E+05	2.5E+05	2.1E+07	8.3E+05	3.9E+06	1.3E+04	8.7E+05	4.0E+05	4.5E+07	2.3E+07
Boyer R.	4.6E+05	6.9E+05	1.9E+05	5.4E+04	8.5E+04	8.4E+03	5.6E+05	6.5E+04	3.2E+05	4.4E+02	1.7E+04	5.2E+03	1.8E+06	1.0E+06
Wabasca R.	2.3E+06	2.8E+06	7.7E+05	2.0E+05	2.3E+05	3.6E+04	2.8E+06	9.4E+04	7.6E+05	2.6E+03	1.1E+05	3.3E+04	4.1E+06	3.5E+06
Mikkwa R.	1.0E+05	1.2E+05	3.5E+04	8.9E+03	1.1E+04	1.1E+03	1.3E+05	6.0E+03	3.1E+04	8.6E+01	7.4E+03	9.4E+02	3.0E+04	1.6E+05
Wentzel R.	2.0E+05	2.6E+05	7.5E+04	1.8E+04	2.9E+04	2.0E+03	2.4E+05	2.7E+04	7.2E+04	1.9E+02	8.1E+03	2.5E+03	4.3E+04	3.2E+05
PR nr Peace Point	2.2E+07	2.5E+07	7.4E+06	1.7E+06	1.0E+06	2.4E+05	2.7E+07	9.0E+05	4.3E+06	1.9E+04	1.1E+06	2.5E+05	1.8E+08	2.8E+07

Loads (kg/d) are based on average concentration and average discharge, as measured in 1988-1989 synoptic surveys.
Example: 1.4E+07 = 1.4 x 10^7 = 14,000,000 kg/d.

Appendix. VII. Continued...

Station	Tann. & Lig.	Oil & Grease	Phenols	DOC	TOC	Total P	Diss. P	NH3 N	NO2+NO3 N	TKN	TN	Total Colif.	Fecal Colif.	Std.Pl. Count
PR nr border	6.4E+04	9.5E+04	2.1E+02	6.1E+05	6.6E+05	1.1E+04	8.4E+02	3.4E+03	5.0E+03	5.8E+04	6.3E+04	7.4E+06	1.8E+06	2.2E+08
Pouce Coupe R.	4.6E+02	1.7E+02	1.2E+00	5.9E+03	6.1E+03	2.3E+01	4.6E+00	4.8E+01	3.4E+01	3.2E+02	3.6E+02	5.0E+04	7.0E+03	1.2E+06
PR nr Dunvegan	6.2E+04	4.9E+04	1.7E+02	6.2E+05	6.7E+05	1.1E+04	7.8E+02	2.2E+03	3.2E+03	5.3E+04	5.6E+04	8.4E+06	1.6E+06	3.4E+08
P.R.Corr.Inst. STP	1.0E-01	1.6E-01	6.9E-04	1.6E+00	1.7E+00	4.2E-01	3.6E-01	1.7E-02	3.9E+00	2.2E-01	4.1E+00	6.1E-01	4.2E-01	1.4E+04
PR u/s Smoky R.	1.1E+05	3.7E+04	1.2E+02	5.7E+05	6.1E+05	1.7E+04	7.5E+02	1.4E+03	4.2E+03	5.0E+04	5.4E+04	7.9E+06	2.0E+06	1.3E+09
Smoky R.	2.6E+04	1.0E+04	9.5E+01	1.1E+05	1.2E+05	1.3E+03	2.0E+02	8.5E+02	5.9E+02	7.6E+03	8.2E+03	1.5E+06	9.3E+04	5.4E+08
Grande Prairie STP	4.0E+00	2.6E+00	2.8E-02	4.1E+01	4.1E+01	1.7E+01	1.5E+01	3.2E+01	1.8E+01	4.2E+01	6.0E+01	8.6E+04	1.2E+04	1.6E+06
P&G Effluent-grab	4.3E+03	3.0E+02	2.8E+01	0.0E+00	1.3E+04	6.7E+01	3.5E+01	6.4E+01	9.3E+00	6.0E+02	6.1E+02	5.2E+05	5.6E+03	3.4E+08
Peace River STP	1.0E+01	2.2E+01	1.5E-01	6.3E+01	6.7E+01	1.4E+01	1.3E+01	4.6E+01	2.6E-01	5.5E+01	5.7E+01	8.3E+06	1.6E+06	3.1E+06
Peace River Oils	0.0E+00	1.2E+01	3.6E-01	2.5E+01	2.7E+01	3.3E-02	0.0E+00	7.9E+01	5.2E-03	9.7E+01	9.7E+01	0.0E+00	0.0E+00	0.0E+00
PR u/s Whitemud R.	8.1E+04	4.9E+04	1.6E+02	7.0E+05	7.3E+05	1.2E+04	8.4E+02	2.7E+03	4.1E+03	5.3E+04	5.7E+04	2.2E+07	3.8E+06	6.5E+08
Whitemud R.	1.2E+03	3.4E+02	2.9E+00	1.4E+04	1.5E+04	2.1E+02	1.4E+01	6.7E+01	3.8E+01	7.2E+02	7.6E+02	1.5E+05	1.1E+04	2.7E+06
Cadotte R.	9.0E+02	3.0E+02	2.3E+00	1.3E+04	1.3E+04	1.3E+02	1.6E+01	5.7E+01	4.6E+01	8.8E+02	9.2E+02	1.4E+05	1.0E+04	2.4E+06
PR u/s Notikewin R.	8.9E+04	7.4E+04	1.8E+02	7.4E+05	7.7E+05	2.0E+04	1.1E+03	2.6E+03	5.8E+03	7.1E+04	7.6E+04	3.4E+07	3.1E+06	1.7E+09
Notikewin R.	6.7E+03	3.2E+03	1.5E+01	8.4E+04	8.5E+04	5.9E+02	7.3E+01	2.4E+02	1.7E+02	3.9E+03	4.1E+03	3.2E+06	3.1E+05	7.9E+06
Wolverine R.	3.0E+03	7.8E+02	6.1E+00	4.0E+04	4.2E+04	4.5E+02	3.2E+01	1.7E+02	1.1E+02	2.6E+03	2.7E+03	6.7E+05	8.3E+04	5.0E+06
Keg R.	1.0E+03	3.1E+02	2.4E+00	1.3E+04	1.3E+04	8.0E+01	1.3E+01	4.3E+01	2.7E+01	6.1E+02	6.4E+02	1.1E+05	8.5E+03	2.0E+06
PR nr Ft. Vermilion	2.1E+05	1.1E+05	2.4E+02	1.6E+06	1.7E+06	4.2E+04	2.1E+03	5.0E+03	4.9E+03	1.2E+05	1.2E+05	4.0E+07	9.6E+06	3.1E+09
Boyer R.	7.9E+03	1.3E+03	1.5E+01	7.3E+04	7.5E+04	1.4E+03	9.5E+01	2.7E+02	3.2E+02	5.6E+03	5.9E+03	1.0E+06	1.4E+05	4.1E+07
Wabasca R.	3.4E+04	7.5E+03	6.3E+01	4.4E+05	4.5E+05	4.3E+03	4.4E+02	1.1E+03	2.1E+03	2.3E+04	2.5E+04	3.4E+06	1.2E+05	2.8E+07
Mikkwa R.	3.0E+03	4.6E+02	3.3E+00	2.3E+04	2.4E+04	8.2E+01	3.3E+01	5.4E+01	9.8E+01	7.5E+02	8.5E+02	3.6E+05	1.2E+04	1.6E+06
Wentzel R.	4.7E+03	9.4E+02	8.1E+00	4.8E+04	4.9E+04	1.1E+02	2.8E+01	1.1E+02	8.9E+01	1.7E+03	1.8E+03	1.4E+05	3.2E+04	2.1E+07
PR nr Peace Point	2.1E+05	1.7E+05	3.4E+02	1.8E+06	2.0E+06	7.6E+04	2.7E+03	1.2E+04	9.3E+03	2.0E+05	2.1E+05	3.3E+07	5.6E+06	1.6E+09

Loads (kg/d) are based on average concentration and average discharge, as measured in 1988-1989 synoptic surveys.
Example: 1.4E+07 = 1.4 x 10^7 = 14,000,000 kg/d.
Loads in units of kg/d, except for bacteria, which is 'pseudo'-kg/d (i.e., bacterial counts x discharge x 86.4).

Appendix. VII. Continued...

Station	Total Al	Diss. Al	Total As	Diss. As	Total Ba	Diss. Ba	Total B	Diss. B	Total Cr	Total Cu	Total Fe	Diss. Fe	Total Pb	Total Mn
PR nr border	7.2E+04	3.4E+03	1.7E+02	3.7E+01	1.1E+04	8.2E+03	6.6E+03	1.4E+03	8.2E+01	4.1E+02	2.5E+05	5.9E+03	3.5E+02	3.5E+03
Pouce Coupe R.	1.6E+02	3.4E+00	5.2E-01	1.9E-01	2.7E+01	2.1E+01	3.0E+01	2.1E+01	9.0E-01	1.3E+00	4.5E+02	3.4E+01	6.9E-01	4.3E+01
PR nr Dunvegan	5.1E+04	1.9E+03	2.9E+02	3.1E+01	1.1E+04	5.8E+03	3.6E+03	1.6E+03	5.4E+02	7.3E+02	4.6E+05	4.3E+03	4.2E+02	5.9E+03
P.R.Corr.Inst. STP	2.0E-02	1.3E-02	1.2E-04	6.7E-05	7.1E-03	4.5E-03	1.5E-02	6.7E-03	2.4E-04	3.2E-03	2.1E-02	1.1E-03	3.9E-04	1.1E-03
PR u/s Smoky R.	9.0E+04	2.6E+03	3.6E+02	3.8E+01	1.4E+04	7.3E+03	4.3E+03	1.5E+03	3.8E+02	4.9E+02	2.2E+05	4.2E+03	2.1E+02	7.9E+03
Smoky R.	1.7E+04	3.4E+02	2.7E+01	7.2E+00	2.1E+03	1.8E+03	7.1E+02	4.1E+02	4.9E+01	7.2E+01	3.7E+04	8.8E+02	3.4E+01	7.4E+02
Grande Prairie STP	2.7E-01	1.9E-01	5.6E-03	6.1E-03	1.3E-01	1.2E-01	8.4E-01	8.1E-01	5.1E-03	2.6E-02	9.4E-01	4.3E-01	1.4E-02	2.4E-01
P&G Effluent-grab	8.9E+01	6.8E+01	7.7E-02	4.5E-02	2.5E+01	1.9E+01	3.0E+00	2.3E+00	1.9E+00	5.5E-01	6.2E+01	5.8E+01	3.6E-01	5.2E+01
Peace River STP	3.4E-01	2.0E-01	3.7E-03	2.2E-03	1.3E-01	4.5E-02	5.0E-01	4.7E-01	5.9E-03	1.2E-01	1.8E+00	6.7E-02	1.6E-02	2.1E-01
Peace River Oils	8.1E-02	0.0E+00	2.1E-03	0.0E+00	1.2E+02	0.0E+00	4.4E+01	0.0E+00	1.7E-03	6.3E-03	1.7E+00	0.0E+00	3.5E-03	1.6E-01
PR u/s Whitemud R.	1.1E+05	2.8E+03	2.1E+02	5.0E+01	1.2E+04	9.3E+03	5.5E+03	3.1E+03	7.5E+02	7.5E+02	3.1E+05	7.4E+03	3.5E+02	4.1E+03
Whitemud R.	1.7E+03	2.4E+01	4.8E+00	5.1E-01	8.4E+01	5.0E+01	5.6E+01	4.0E+01	3.1E+00	5.5E+00	5.0E+03	1.8E+02	2.6E+00	1.6E+02
Cadotte R.	1.5E+03	8.4E+00	2.4E+00	5.0E-01	7.0E+01	4.6E+01	5.4E+01	3.9E+01	8.8E-01	2.6E+00	1.7E+03	7.9E+01	1.2E+00	7.8E+01
PR u/s Notikewin R.	4.7E+05	2.4E+03	6.2E+02	7.6E+01	1.7E+04	9.1E+03	4.1E+03	2.4E+03	5.1E+02	8.7E+02	5.1E+05	8.7E+03	5.4E+02	8.7E+03
Notikewin R.	7.0E+03	9.2E+01	1.5E+01	2.7E+00	4.3E+02	2.2E+02	3.2E+02	2.2E+02	2.8E+01	2.9E+01	2.2E+04	1.5E+03	2.0E+01	3.9E+02
Wolverine R.	8.7E+03	2.9E+01	8.0E+00	1.1E+00	2.1E+02	9.2E+01	9.8E+01	4.3E+01	7.6E+00	1.6E+01	1.2E+04	3.9E+02	8.7E+00	2.7E+02
Keg R.	7.8E+02	8.6E+00	2.0E+00	4.0E-01	5.7E+01	4.0E+01	5.3E+01	3.9E+01	7.8E-01	4.9E+00	2.3E+03	1.5E+02	2.2E+00	5.7E+01
PR nr Ft. Vermilion	1.2E+06	4.4E+03	6.8E+02	7.8E+01	2.6E+04	1.2E+04	1.1E+04	5.2E+03	9.7E+02	2.4E+03	1.3E+06	3.7E+04	1.2E+03	1.8E+04
Boyer R.	2.8E+04	1.1E+02	3.5E+01	2.6E+00	9.8E+02	2.1E+02	3.4E+02	1.5E+02	3.6E+01	7.6E+01	2.4E+04	1.1E+03	3.9E+01	9.1E+02
Wabasca R.	5.0E+04	3.4E+02	7.1E+01	1.6E+01	1.9E+03	1.1E+03	1.2E+03	9.6E+02	9.3E+01	1.4E+02	1.1E+05	5.5E+03	9.3E+01	2.7E+03
Mikkwa R.	3.7E+02	2.5E+01	1.5E+00	7.1E-01	4.5E+01	4.3E+01	4.7E+01	3.3E+01	1.1E+01	1.9E+00	1.7E+03	6.6E+02	3.4E+00	5.6E+01
Wentzel R.	1.4E+03	5.3E+01	2.5E+00	9.2E-01	1.2E+02	1.2E+02	1.3E+02	8.9E+01	5.3E+00	1.4E+01	4.8E+03	8.1E+02	8.6E+00	2.1E+02
PR nr Peace Point	1.9E+06	1.4E+04	1.4E+03	9.8E+01	4.3E+04	1.6E+04	1.3E+04	7.6E+03	1.7E+03	2.9E+03	2.3E+06	2.0E+04	1.9E+03	3.4E+04

Loads are based on average concentration and average discharge, as measured in 1988-1989 synoptic surveys.
Example: 1.4E+07 = 1.4 x 10^7 = 14,000,000 kg/d.

Appendix. VII. Continued...

Station	Total Mo	Total Ni	Diss. Ni	Total Se	Total V	Total Zn
PR nr border	6.2E+02	1.0E+03	1.6E+02	4.6E+02	6.4E+02	1.9E+03
Pouce Coupe R.	1.1E+00	2.7E+00	1.1E+00	1.1E-01	6.9E-01	3.0E+00
PR nr Dunvegan	1.9E+03	8.7E+02	2.3E+02	4.2E+01	7.3E+02	2.2E+03
P.R.Corr.Inst. STP	5.1E-04	4.3E-04	7.3E-04	3.2E-05	6.1E-04	9.9E-03
PR u/s Smoky R.	7.9E+02	7.3E+02	1.9E+02	4.7E+01	4.9E+02	2.0E+03
Smoky R.	1.3E+02	7.0E+01	2.2E+01	4.6E+00	2.1E+01	1.8E+02
Grande Prairie STP	1.7E-02	1.8E-02	1.3E-02	1.3E-03	7.3E-03	8.2E-02
P&G Effluent-grab	6.0E-01	7.8E-01	9.7E-01	9.3E-03	2.9E-01	1.1E+01
Peace River STP	6.9E-03	1.3E-02	6.7E-03	4.5E-04	1.8E-03	9.7E-02
Peace River Oils	2.5E-02	2.3E-03	0.0E+00	5.8E-04	4.6E-03	1.7E-02
PR u/s Whitemud R.	3.7E+02	9.4E+02	2.5E+02	4.1E+01	7.9E+02	1.9E+03
Whitemud R.	8.2E+00	1.3E+01	4.5E+00	4.3E-01	7.2E+00	1.8E+01
Cadotte R.	4.8E+00	5.6E+00	1.7E+00	2.2E-01	1.8E+00	1.7E+01
PR u/s Notikewin R.	5.7E+02	1.4E+03	3.8E+02	4.0E+01	9.8E+02	3.6E+03
Notikewin R.	1.6E+01	6.0E+01	1.5E+01	8.7E-01	3.7E+01	8.0E+01
Wolverine R.	1.0E+01	2.8E+01	7.2E+00	4.0E-01	2.0E+01	4.2E+01
Keg R.	2.7E+00	7.1E+00	2.7E+00	1.6E-01	3.8E+00	8.8E+00
PR nr Ft. Vermilion	1.2E+03	2.4E+03	7.6E+02	4.3E+01	2.4E+03	5.4E+03
Boyer R.	7.0E+01	7.8E+01	2.0E+01	2.5E+00	7.6E+01	1.5E+02
Wabasca R.	9.1E+01	2.1E+02	1.0E+02	4.4E+00	2.0E+02	4.8E+02
Mikkwa R.	4.9E+00	3.1E+00	2.9E+00	3.0E-01	3.3E+00	4.5E+00
Wentzel R.	1.1E+01	1.2E+01	6.2E+00	4.7E-01	1.3E+01	4.7E+01
PR nr Peace Point	1.4E+03	4.7E+03	1.3E+03	8.8E+01	4.2E+03	1.1E+04

Loads (kg/d) are based on average concentration and average discharge,
Example: 1.4E+07 = 1.4 x 10^7 = 14,000,000 kg/d.

Appendix VIII. Years samples were collected and total number of samples analyzed for pesticides and their derivitives.

	Smoky R.* at Watino	Dunvegan*	Peace River: Peace River	Peace River: Ft. Vermilion
Insecticides				
Aldrin	1971-1986(39)	1971-1988(43)	1971-1973(7)	1971-1973(7)
Azinphosethyl	1979-1986(28)	1979-1988(33)		
α-BHC	1975-1986(41)	1978-1988(40)		
γ-BHC	1971-1986(47)	1971-1988(44)	1971-1973(8)	1971-1973(8)
Carbophenothion	1978-1986(34)	1978-1988(40)		
α-Chlordane	1978-1986(35)	1978-1988(40)		
γ-Chlordane	1978-1986(35)	1978-1988(40)		
Crufomate	1979-1986(29)	1979-1988(33)		
Diazionon	1978-1986(34)	1978-1988(39)		
Disulfoton	1979-1986(26)	1979-1988(33)		
p,p-DDD	1971-1986(39)	1971-1988(44)	1971-1973(8)	1971-1973(8)
p,p-DDE	1971-1986(39)	1971-1988(44)	1971-1973(8)	1971-1973(8)
o,p-DDT	1978-1986(33)	1978-1988(38)		
p,p-DDT	1971-1986(39)	1971-1988(44)	1971-1973(8)	1971-1973(8)
Dieldrin	1971-1986(39)	1971-1988(44)	1971-1973(8)	1971-1973(8)
α-Endosulfan	1971-1986(39)	1971-1988(44)	1971-1973(8)	1971-1973(8)
β-Endosulfan	1971-1986(39)	1971-1988(44)	1971-1973(8)	1971-1973(8)
Endrin	1978-1986(35)	1978-1988(40)		
Ethion	1978-1986(34)	1978-1988(40)		
Fenchlorphos	1979-1986(29)	1979-1988(34)		
Guthion	1978-1986(34)	1978-1988(39)		
Heptachlor	1971-1986(39)	1971-1988(44)	1971-1973(8)	1971-1973(8)
Heptachlor epoxide	1971-1986(39)	1971-1988(44)	1971-1973(8)	1971-1973(8)
Imidan	1979-1986(28)	1979-1988(33)		
Malathion	1978-1986(34)	1978-1988(40)		
Mirex	1978-1986(33)	1978-1988(38)		
p,p-Methoxychlor	1971-1986(39)	1971-1988(44)	1971-1973(8)	1971-1973(8)
Parathion	1978-1986(35)	1978-1988(40)		
Parathion methyl	1978-1986(30)	1978-1988(35)		
Phorate	1979-1986(28)	1979-1988(33)		
Herbicides				
2,4-D	1972-1986(47)	1972-1988(42)	1972-1974(6)	1972-1974(6)
2,4-DB	1972-1986(46)	1972-1988(40)	1972-1974(5)	1973-1974(5)
2,4-DP	1972-1986(46)	1972-1988(40)	1972-1974(5)	1973-1974(5)
Diacamba	1985(3)	1985-1988(3)		
Hexachlorobenzene	1978-1986(33)	1978-1988(38)		
MCPA	1973-1986(47)	1973-1988(39)	1973-1974(4)	1973-1974(4)
MCPB	1985(29)	1985-1988(3)		
Picloram	1978-1985(12)	1985-1988(2)		
Silvex	1978-1986(32)	1978-1988(34)		
2,4,5-T	1972-1986(47)	1972-1988(42)	1972-1974(6)	1972-1974(6)
2,3,6-TBA	1985(2)	1985-1988(3)		

* Compiled to dates shown, sampling is ongoing for most pesticides.

Appendix IX. Physical characteristics measured at zoobenthic sites in the Peace River in the fall of 1988.

Site	Flow Velocity (m/s)			Sampling Depth (cm)			Substrate Composition (% weight)			
	Mean	Min	Max	Mean	Min	Max	Cobble	Coarse Pebble	Fine Pebble	Sand
Border-r	0.317	0.141	0.536	30	30	31	20.8	52.1	18.8	9.3
Border-l	0.368	0.210	0.485	30	28	32	48.3	30.87	11.9	9.1
0.25 km u/s Clear River-r	0.457	0.347	0.657	40	34	46	25.7	22.1	33.1	9.1
4.2 km u/s Clear River-c	0.734	0.622	0.846	42	40	45	30.9	51.5	4.4	13.2
0.25 km u/s Clear River-l	0.402	0.296	0.485	43	40	46	63.5	12.8	10.3	13.5
near Dunvegan	0.543	0.382	0.708	43	38	50	33.7	55.7	7.8	2.7
u/s Smoky River	0.139	0.118	0.164	36	35	38	0.0	58.9	14.3	26.8
4 km u/s Daishowa-r	0.306	0.261	0.399	36	30	42	45.8	50.0	2.5	1.7
3 km u/s Daishowa-c	0.203	0.176	0.261	36	34	40	75.3	17.8	4.1	2.7
2 km d/s Daishowa-r	0.626	0.554	0.657	21	15	26	28.3	49.2	19.2	3.3
5 km d/s Daishowa-l	0.537	0.484	0.588	22	18	26	57.7	37.1	4.1	1.0
7 km d/s Daishowa-c	0.615	0.416	0.863	23	14	27	64.3	25.0	7.1	3.6
17 km d/s Daishowa-l	0.547	0.485	0.571	6	5	9	23.8	52.4	19.1	4.8
20 km d/s Daishowa-r	0.708	0.605	0.794	20	15	26	46.3	39.6	11.4	2.7
32 km d/s Daishowa-r	0.303	0.210	0.330	34	34	36	6.4	50.0	57.3	6.4
33 km d/s Daishowa-c	0.586	0.554	0.620	33	30	36	12.2	48.8	22.6	9.5
35 km d/s Daishowa-l	0.626	0.554	0.881	36	30	43	61.7	34.9	3.4	0.0
u/s Notikewin River	0.622	0.554	0.691	36	35	38	13.9	40.6	28.3	17.1
near Carcajou	0.407	0.347	0.450	35	30	40	7.8	30.5	33.6	28.1
near La Crete	0.177	0.141	0.244	39	30	45	-	-	-	100
near Fort Vermilion	0.204	0.181	0.233	37	33	42	-	-	-	100
u/s Wood Buffalo	0.231	0.176	0.267	30	28	32	-	-	-	100
near Peace Point	0.176	0.170	0.181	37	35	38	-	-	-	100

u/s - upstream, d/s - downstream, r - right bank, l - left bank, c - centre

Appendix X. Zoobenthos data for the Peace River, 1987-1988.

Counts for five individual replicate samples.

POLLUTION CONTROL DIVISION — May 26, 1987

PEACE RIVER - BORDER (LEFT BANK) — 00BCGTFD1000

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	0	14	11	16	17
Naididae	11	13	23	10	20
ARTHROPODA					
ARACHNOIDA					
ARANEA	0	1	0	0	0
CRUSTACEA					
CLADOCERA					
Daphniidae	1	0	0	0	0
Daphnia	14	9	14	11	6
COPEPODA					
Cyclopoida	66	69	63	55	76
Harpacticoida	0	1	0	0	0
Calanoida	31	33	44	26	46
INSECTA					
COLLEMBOLA	1	1	0	0	0
DIPTERA					
Ceratopogonidae	0	0	0	1	0
Chironomidae					
Chironomidae pupae	0	0	1	2	2
Chironomini	1	1	1	2	1
Diamesinae	0	0	0	1	0
Orthocladiinae	2	7	9	3	9
Tanypodinae	0	0	1	2	1
Tanytarsini	3	1	0	0	1
Simuliidae	2	1	2	1	3
Diptera adults	0	0	0	0	1
EPHEMEROPTERA					
Baetidae	0	0	1	0	0
Ephemerellidae					
Ephemerella	2	1	3	1	1
PLECOPTERA					
Chloroperlidae					
Sweltsa complex	0	0	0	0	1
Perlodidae	0	0	0	0	2
TRICHOPTERA					
Leptoceridae					
Ceraclea	1	0	0	0	0
TERRESTRIAL INSECTS	1	2	0	0	0
COELENTERATA	1	0	0	2	1
NEMATODA	2	0	3	2	3

POLLUTION CONTROL DIVISION — Sept. 28, 1987

PEACE RIVER - BORDER (LEFT BANK) — 00BCGTFD1000

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	13	9	10	24	20
Naididae	3	3	6	3	2
Tubificidae	0	0	0	0	1
ARTHROPODA					
ARACHNOIDA					
ACARI	4	5	7	1	2
CRUSTACEA					
CLADOCERA					
Daphniidae					
Daphnia	4	15	6	14	17
COPEPODA					
Cyclopoida	6	2	5	13	2
Harpacticoida	0	0	2	1	0
Calanoida	63	105	32	75	50
OSTRACODA	0	0	2	0	0
INSECTA					
DIPTERA					
Atherididae					
Atheria	0	0	0	1	0
Chironomidae					
Chironomidae pupae	0	0	1	0	0
Chironomini	1	0	2	6	1
Orthocladiinae	13	5	8	3	8
Tanypodinae	3	1	4	0	0
Tanytarsini	1	0	0	0	0
Empididae					
Hemerodromia	1	1	0	0	0
Tipulidae					
Limnophila	0	0	1	1	0
Diptera pupae	0	0	1	0	0
EPHEMEROPTERA					
Baetidae	1	1	2	4	0
Baetis	1	0	0	0	0
Ephemerellidae					
Ephemerella	24	6	12	11	11
Heptageniidae	5	5	9	10	6
Heptagenia	0	0	2	0	0
Rhithrogena	21	6	35	30	8
HEMIPTERA					
Corixidae	0	0	1	0	0
PLECOPTERA					
Capniidae	4	2	6	12	3
Chloroperlidae	2	0	10	4	2
Nemouridae					
Zapada	0	0	0	0	1
Perlidae	0	0	1	0	0
Claassenia sabulosa	0	0	3	1	2
Hesperoperla	0	0	1	0	2
Perlodidae	19	6	20	33	11
Isogenoides	6	2	8	9	2
Isoperla	0	0	1	0	0
Pteronarcyidae					
Pteronarcella	0	0	1	0	0
Taeniopterygidae					
Oemopteryx	46	21	18	17	12
Plecoptera immature	0	0	0	0	1
TRICHOPTERA					
Brachycentridae					
Brachycentrus	1	0	0	0	0
Glossosomatidae					
Glossosoma	0	0	1	0	0
Hydropsychidae	0	2	0	0	0
Arctopsyche	2	0	2	0	0
Cheumatopsyche	1	0	0	0	0
Hydropsyche	3	0	0	0	0
Lepidostomatidae					
Lepidostoma	0	0	1	0	0
COELENTERATA	135	77	223	97	79
NEMATODA	1	2	1	3	1

POLLUTION CONTROL DIVISION — July 21, 1980

PEACE RIVER - BORDER (LEFT BANK) — 08BC07FB100C

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	34	3	92	23	25
Naididae	8	2	36	13	20
ARTHROPODA					
ARACHNOIDA					
ACARI	2	0	2	3	2
CRUSTACEA					
CLADOCERA					
Daphnidae					
Daphnia	276	8	111	240	88
Bosminidae					
Bosmina	2	0	4	9	3
Chydoridae	0	0	0	1	0
COPEPODA					
Cyclopoida	192	4	72	121	56
Calanoida	460	15	176	338	156
OSTRACODA	1	0	0	0	0
INSECTA					
COLEOPTERA	0	1	0	0	0
COLLEMBOLA	0	0	0	0	1
DIPTERA					
Chironomidae					
Chironomidae pupae	0	0	2	1	3
Chironomini	3	6	14	10	11
Orthocladiinae	27	1	16	27	7
Tanypodinae	0	0	1	0	0
Tanyderidae	0	0	1	0	0
Tipulidae	0	0	1	0	0
Diptera pupae	0	1	1	2	0
Diptera adults	1	0	0	0	0
EPHEMEROPTERA					
Baetidae	8	0	1	12	1
Baetis	12	0	0	1	1
Ephemerellidae	1	0	0	0	0
Ephemerella	5	3	4	3	0
Heptageniidae	1	3	2	7	6
Cinygmula	0	0	0	1	0
Heptagenia	0	0	2	1	0
Rhithrogena	1	0	0	2	0
Siphlonuridae	0	0	1	0	1
Ameletus	1	2	1	3	0
HEMIPTERA	0	0	0	1	0
PLECOPTERA					
Chloroperlidae	1	1	3	0	0
Perlodidae	0	0	0	3	1
Isogenoides	0	0	0	1	0
Isoperla	1	0	4	0	0
Plecoptera immature	13	2	8	10	4
TRICHOPTERA					
Hydropsychidae	12	0	1	7	3
Arctopsyche	3	1	1	3	0
TERRESTRIAL INSECTS	0	0	0	1	0
COELENTERATA	101	13	58	87	49
NEMATODA	4	6	9	10	5

POLLUTION CONTROL DIVISION — Oct. 3, 1980

PEACE RIVER - BORDER (LEFT BANK) — 08BC07FB100C

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	333	636	573	480	380
Naididae	2211	1392	1172	1392	1012
Tubificidae	340	213	246	186	120
ARTHROPODA					
ARACHNOIDA					
ACARI	0	0	0	0	1
CRUSTACEA					
CLADOCERA					
Daphnidae	0	1	0	0	0
Bosminidae	0	0	1	0	0
COPEPODA					
Cyclopoida	1	1	1	1	3
Calanoida	5	6	9	8	3
INSECTA					
COLEOPTERA					
Dytiscidae	0	0	0	0	1
DIPTERA					
Chironomidae					
Chironomidae pupae	0	0	0	1	0
Chironomini	0	0	1	0	0
Diamesinae	1	0	0	1	0
Orthocladiinae	6	19	29	10	22
Dolichopodidae	0	0	0	1	1
Tipulidae	0	2	0	1	0
Discomyia	0	0	0	1	0
PLECOPTERA	0	0	1	1	0
COELENTERATA					
HYDROZOA					
HYDROIDEA					
Hydridae	4	12	15	8	13
NEMATODA	81	99	198	150	117

POLLUTION CONTROL DIVISION — May 28, 1987

PEACE RIVER - BORDER (RIGHT BANK) — 008C07FD1100

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	3	18	7	23	9
Lumbriculidae	0	0	1	0	2
Naididae	14	10	4	8	6
ARTHROPODA					
ARACHNOIDA					
ACARI	0	0	0	0	2
CRUSTACEA					
CLADOCERA					
Daphniidae					
Daphnia	0	0	1	0	1
COPEPODA					
Cyclopoida	15	6	19	7	5
Harpacticoida	0	2	0	0	4
Calanoida	4	6	3	12	8
INSECTA					
COLLEMBOLA	0	1	0	0	0
DIPTERA					
Athericidae					
Atheris	0	1	0	0	0
Chironomidae					
Chironomidae pupae	0	0	0	1	0
Chironomini	20	9	2	14	10
Orthocladiinae	2	7	2	5	1
Tanypodinae	2	1	1	1	1
Tanytarsini	2	0	0	1	1
Empididae					
Chelifera	1	0	0	0	0
Simuliidae	1	2	1	1	1
Diptera adults	1	0	0	0	0
EPHEMEROPTERA					
Baetidae	0	0	2	1	0
Baetis	2	2	2	0	3
Ephemerellidae					
Ephemerella	12	11	9	4	11
Heptageniidae	0	0	0	1	1
Rhithrogena	0	0	1	0	0
Siphlonuridae					
Ameletus	0	1	0	0	0
Ephemeroptera immatures	1	0	1	0	0
PLECOPTERA					
Chloroperlidae	1	0	1	0	0
Suwallia complex	4	4	0	0	2
Perlodidae	3	3	0	1	2
Taeniopterygidae					
Doncopteryx	0	0	1	0	0
Plecoptera immature	1	2	1	3	1
TRICHOPTERA					
Lepidostomatidae					
Lepidostoma	0	1	0	0	0
TERRESTRIAL INSECTS	0	0	0	1	0
COELENTERATA	0	1	1	0	1
NEMATODA	0	1	0	1	1

POLLUTION CONTROL DIVISION — Sept. 28, 1987

PEACE RIVER - BORDER (RIGHT BANK) — 008C07FD1100

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	3	7	9	2	5
Naididae	11	7	7	6	12
ARTHROPODA					
ARACHNOIDA					
ACARI	31	5	12	30	38
CRUSTACEA					
CLADOCERA					
Daphniidae					
Daphnia	4	3	3	3	3
COPEPODA					
Cyclopoida	3	4	2	1	5
Calanoida	16	30	40	38	33
OSTRACODA	0	0	1	1	0
INSECTA					
DIPTERA					
Athericidae					
Atheris	0	1	0	0	0
Chironomidae					
Chironomidae pupae	0	0	0	1	1
Chironomini	1	0	1	0	0
Diamesinae	1	0	0	0	0
Orthocladiinae	40	30	19	20	43
Tanypodinae	4	3	2	3	1
Tanytarsini	0	0	0	0	1
Empididae					
Chelifera	2	0	0	0	3
Clinocera	0	0	0	0	1
Hemerodromia	0	1	0	0	1
Tipulidae					
Limnophila	0	3	0	0	0
EPHEMEROPTERA					
Baetidae	1	2	0	1	0
Baetis	1	0	1	0	0
Caenidae					
Caenis	0	1	0	0	0
Ephemerellidae					
Ephemerella	16	13	9	12	38
Heptageniidae	0	3	1	1	0
Heptagenia	0	0	0	1	1
Siphlonuridae					
Ameletus	0	0	0	0	2
HEMIPTERA					
Corixidae	1	0	2	1	1
PLECOPTERA					
Capniidae	44	28	34	32	32
Chloroperlidae	0	2	2	3	7
Suwallia complex	0	0	0	1	0
Perlodidae	19	12	11	16	9
Isogenoides	17	8	1	4	2
Isoperla	0	0	0	0	1
Skwala	1	0	0	0	0
Taeniopterygidae					
Doncopteryx	28	5	12	13	33
Plecoptera immature	0	3	1	1	0
TRICHOPTERA					
Brachycentridae					
Brachycentrus	0	0	0	1	0
Hydropsychidae	1	0	1	1	0
Arctopsyche	0	0	0	0	1
Cheumatopsyche	1	0	0	0	3
Hydropsyche	3	2	1	2	4
Hydroptilidae	1	0	0	0	0
Trichoptera immatures	0	0	0	0	1
COELENTERATA	362	276	306	236	134
NEMATODA	0	1	1	0	0

POLLUTION CONTROL DIVISION — July 21, 1988

PEACE RIVER - BORDER (RIGHT BANK) — 008C07FD110:

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	19	13	9	10	17
Naididae	12	13	15	8	2C
Tubificidae	0	0	1	0	3
ARTHROPODA					
ARACHNOIDA					
ACARI	3	3	2	3	5
CRUSTACEA					
CLADOCERA					
Daphnidae					
Daphnia	92	116	118	180	184
Bosminidae					
Bosmina	0	3	2	1	2
COPEPODA					
Cyclopoida	38	53	53	66	54
Calanoida	142	129	116	156	159
INSECTA					
COLEOPTERA	1	C	0	C	C
COLLEMBOLA	0	0	0	1	C
DIPTERA					
Ceratopogonidae	0	0	0	0	1
Chironomidae					
Chironomidae pupae	2	1	2	8	5
Chironomini	257	142	90	95	7C
Orthocladiinae	20	5	4	11	23
Tanypodinae	0	0	0	0	2
Tanytarsini	2	2	3	0	C
Empididae					
Chelifera	1	0	0	0	0
Muscidae	1	0	0	0	0
Tipulidae	3	1	2	0	C
Diptera pupae	0	0	1	0	1
EPHEMEROPTERA					
Baetidae	0	0	0	3	E
Baetis	0	0	1	3	7
Ephemerellidae	1	C	0	0	1
Ephemerella	1	5	4	13	10
Heptageniidae	0	1	3	1	E
Heptagenia	0	3	1	2	1
Rhithrogena	0	0	0	1	1
Siphlonuridae	0	0	1	0	C
Ameletus	0	0	1	1	C
Tricorythidae					
Tricorythodes	0	1	0	0	1
Ephemeroptera immatures	0	0	0	0	1
PLECOPTERA					
Capniidae	0	0	0	0	1
Chloroperlidae	0	0	0	0	2
Suwallia complex	1	0	0	0	3
Nemouridae	0	0	0	0	1
Amphinemura	0	0	0	0	1
Perlodidae	1	3	3	5	10
Isogenoides	0	0	0	0	1
Taeniopterygidae	2	0	0	1	0
Plecoptera immature	3	1	1	6	12
TRICHOPTERA					
Hydropsychidae	0	0	0	1	8
Arctopsyche	0	0	0	1	5
COELENTERATA	75	90	194	102	306
MOLLUSCA					
GASTROPODA					
PULMONATA					
Lymnaeidae					
Lymnaea	1	0	0	0	0
NEMATODA	8	15	18	7	11

POLLUTION CONTROL DIVISION — Oct. 3, 1988

PEACE RIVER - BORDER (RIGHT BANK) — 008C07FD11C0

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	103	79	65	141	158
Naididae	325	268	534	370	276
Tubificidae	0	2	0	5	[illegible]
ARTHROPODA					
ARACHNOIDA					
ACARI	1	0	0	0	6
CRUSTACEA					
CLADOCERA					
Daphnidae	0	1	0	1	6
Chydoridae	1	0	0	1	0
COPEPODA					
Cyclopoida	4	0	3	0	3
Harpacticoida	2	1	0	0	1
Calanoida	2	1	3	8	2
OSTRACODA	2	0	2	1	0
INSECTA					
COLLEMBOLA	0	0	0	1	0
DIPTERA					
Chironomidae					
Chironomidae pupae	1	0	0	1	6
Chironomini	12	2	2	2	1
Diamesinae	1	5	5	5	3
Orthocladiinae	34	26	7	21	4
Tanypodinae	2	1	0	0	0
Tanytarsini	58	40	22	22	9
Tipulidae	0	0	2	0	0
Dicranota	1	0	0	0	0
EPHEMEROPTERA					
Heptageniidae	0	1	0	1	0
HEMIPTERA					
Corixidae	2	0	0	0	0
PLECOPTERA	1	0	0	0	0
Capniidae	10	0	0	0	0
COELENTERATA					
HYDROZOA					
HYDROIDEA					
Hydridae	10	5	17	11	11
MOLLUSCA	0	0	1	0	0
NEMATODA	358	116	51	49	31

POLLUTION CONTROL DIVISION — Sept. 26, 1987

PEACE RIVER - 4.2 KM UPSTREAM OF CLEAR RIVER (CENTRE) — 00AL07FD100C

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	13	32	28	19	31
Naididae	0	3	6	4	2
Tubificidae	2	0	0	0	0
ARTHROPODA					
ARACHNOIDA					
ACARI	8	7	4	5	1
CRUSTACEA					
CLADOCERA					
Daphnidae					
Daphnia	1	8	2	13	2
COPEPODA					
Cyclopoida	3	1	4	8	1
Calanoida	14	38	28	60	37
OSTRACODA	1	0	0	0	6
INSECTA					
DIPTERA					
Chironomidae.					
Chironomidae pupae	1	0	1	1	1
Chironomini	6	4	4	1	2
Orthocladiinae	9	16	6	8	9
Tanypodinae	1	2	2	1	0
Empididae					
Hemerodromia	0	0	2	1	0
Simuliidae	0	0	0	0	1
EPHEMEROPTERA					
Baetidae	0	1	0	2	0
Ephemerellidae					
Ephemerella	8	4	12	4	2
Heptageniidae	3	3	8	9	6
Heptagenia	0	1	1	0	0
Rhithrogena	5	10	4	9	6
PLECOPTERA					
Capniidae	9	3	6	7	3
Chloroperlidae	5	2	7	1	1
Perlodidae	9	5	16	12	1
Isogenoides	0	3	8	3	1
Taeniopterygidae					
Oemopteryx	15	13	24	25	8
Plecoptera immature	0	0	1	1	1
TRICHOPTERA					
Hydropsychidae					
Arctopsyche	2	0	2	0	0
Hydropsyche	2	1	1	1	0
COELENTERATA	94	266	172	199	136
NEMATODA	5	14	10	8	6

POLLUTION CONTROL DIVISION — Sept. 27, 1988

PEACE RIVER - 4.2 KM UPSTREAM OF CLEAR RIVER (CENTRE) — 00AL07FD100C

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	88	65	248	178	142
Naididae	36	15	75	68	41
Tubificidae	1	2	1	0	6
ARTHROPODA					
ARACHNOIDA					
ACARI	0	0	0	1	2
CRUSTACEA					
CLADOCERA					
Daphnidae	10	0	6	4	9
Bosminidae	2	1	1	2	2
Chydoridae	2	0	1	0	0
COPEPODA					
Cyclopoida	19	11	8	10	8
Harpacticoida	1	0	0	0	1
Calanoida	86	39	31	51	56
OSTRACODA	0	0	1	0	0
INSECTA					
DIPTERA					
Chironomidae					
Chironomidae pupae	0	0	0	1	0
Chironomini	1	0	5	2	1
Diamesinae	0	0	1	0	0
Orthocladiinae	9	22	30	23	22
Tanytarsini	0	0	1	0	0
Simuliidae	0	1	0	0	0
Tanyderidae					
Protanyderus	0	0	1	0	0
Tipulidae	0	0	0	1	1
Diptera pupae	0	0	1	0	0
Diptera adults	0	0	0	0	1
EPHEMEROPTERA					
Baetidae	0	0	0	0	2
Baetis	0	0	1	0	0
Ephemerellidae					
Ephemerella	1	1	2	1	0
Heptageniidae	4	1	4	0	1
Heptagenia	1	0	0	0	0
Rhithrogena	0	0	1	2	0
PLECOPTERA	2	0	2	1	1
Capniidae	2	0	0	0	1
Chloroperlidae	1	0	0	1	0
Perlodidae	1	1	1	0	0
Taeniopterygidae	1	0	0	4	3
TRICHOPTERA					
Glossosomatidae					
Glossosoma	1	0	0	0	0
Hydropsychidae	1	0	0	0	0
COELENTERATA					
HYDROZOA					
HYDROIDEA					
Hydridae	37	17	19	83	20
NEMATODA	22	17	142	68	83

POLLUTION CONTROL DIVISION

PEACE RIVER - 0.25 KM UPSTREAM OF CLEAR RIVER (LEFT BANK)

May 28, 1987

004L07FD105C

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	12	14	10	4	12
Naididae	10	16	7	6	13
ARTHROPODA					
ARACHNOIDA					
ACARI	0	0	1	0	0
CRUSTACEA					
CLADOCERA					
Daphnidae					
Daphnia	3	2	3	1	0
COPEPODA					
Cyclopoida	28	46	29	18	37
Calanoida	10	14	20	18	17
OSTRACODA	0	0	1	3	0
INSECTA					
COLEOPTERA					
Curculionidae	0	0	1	0	1
COLLEMBOLA	0	0	0	0	1
DIPTERA	3	1	3	0	1
Ceratopogonidae	0	0	1	1	0
Chironomidae					
Chironomidae pupae	4	2	0	2	1
Chironomini	13	9	17	8	4
Diamesinae	0	0	1	0	0
Orthocladiinae	16	11	15	13	13
Tanypodinae	1	1	1	1	0
Tipulidae					
Limnophila	0	0	0	1	0
EPHEMEROPTERA					
Baetidae	0	0	0	0	1
Siphlonuridae					
Ameletus	1	1	0	0	0
Ephemeroptera immatures	0	0	0	1	2
PLECOPTERA					
Plecoptera immature	1	0	0	0	0
TERRESTRIAL INSECTS	2	3	25	1	0
COELENTERATA	2	2	4	0	0
NEMATODA	14	16	21	2	1

POLLUTION CONTROL DIVISION

PEACE RIVER - 0.25 KM UPSTREAM OF CLEAR RIVER (LEFT BANK)

Sept. 28, 1987

004L07FD105S

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	12	7	12	8	9
Naididae	1	1	6	1	6
Tubificidae	0	2	0	0	0
ARTHROPODA					
ARACHNOIDA					
ACARI	17	38	29	26	32
CRUSTACEA					
CLADOCERA					
Daphnidae					
Daphnia	0	1	1	1	1
COPEPODA					
Cyclopoida	0	0	0	1	4
Harpacticoida	0	0	0	4	0
Calanoida	4	2	11	4	4
OSTRACODA	1	0	1	0	0
INSECTA					
DIPTERA					
Athericidae					
Atheria	0	0	0	1	0
Ceratopogonidae	0	2	0	2	0
Chironomidae					
Chironomini	4	5	1	7	5
Orthocladiinae	171	122	187	121	156
Tanypodinae	8	7	6	9	1
Tanytarsini	4	1	3	4	2
Prodiamesinae	1	0	0	0	0
Empididae					
Chelifera	0	3	1	0	0
Hemerodromia	3	2	0	1	0
Tipulidae					
Limnophila	0	2	0	1	0
EPHEMEROPTERA					
Baetidae					
Baetis	0	0	1	0	1
Ephemerellidae					
Ephemerella	9	5	1	7	9
Heptageniidae	0	2	0	0	5
Heptagenia	0	0	0	1	0
Rhithrogena	11	2	1	3	8
HEMIPTERA					
Corixidae	0	1	0	1	2
PLECOPTERA					
Capniidae	122	85	37	53	41
Chloroperlidae	12	12	5	7	3
Perlidae					
Hesperoperla	0	0	0	0	1
Perlodidae	9	9	4	5	21
Isogenoides	4	8	0	3	8
Taeniopterygidae					
Doncopteryx	3	0	2	1	4
TRICHOPTERA					
Brachycentridae					
Brachycentrus	1	1	0	0	0
Glossosomatidae					
Glossosoma	1	0	1	0	0
Hydropsychidae	0	1	0	0	2
Arctopsyche	0	0	0	0	1
Cheumatopsyche	1	0	0	0	0
Hydropsyche	1	0	0	0	1
COELENTERATA	150	219	164	130	237
NEMATODA	2	3	7	0	4

POLLUTION CONTROL DIVISION — July 21, 1988

PEACE RIVER - 0.25 KM UPSTREAM OF CLEAR RIVER (LEFT BANK) — 08AL07FD105C

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	32	50	47	60	34
Naididae	72	39	15	14	9
ARTHROPODA					
ARACHNOIDA					
ACARI	2	0	0	0	0
CRUSTACEA					
CLADOCERA					
Daphnidae					
Daphnia	113	110	130	143	119
Bosminidae					
Bosmina	1	2	5	2	2
COPEPODA					
Cyclopoida	70	52	58	79	59
Calanoida	193	110	150	178	147
INSECTA					
COLEOPTERA					
Dytiscidae	0	0	0	0	1
Hydrophilidae	0	2	0	0	0
DIPTERA					
Chironomidae					
Chironomidae pupae	6	1	2	0	0
Chironomini	34	78	37	24	55
Orthocladiinae	10	4	8	3	24
Tanypodinae	1	0	0	0	0
Tanytarsini	1	1	0	0	1
Diptera adults	5	1	1	0	2
EPHEMEROPTERA					
Baetidae	10	1	2	0	1
Baetis	1	0	1	1	1
Ephemerellidae					
Ephemerella	5	1	0	0	3
Heptageniidae	9	1	2	2	0
Heptagenia	0	1	3	2	0
Rhithrogena	0	0	1	1	1
Leptophlebiidae	0	1	0	0	2
Siphlonuridae	1	0	0	0	0
Ameletus	3	0	0	1	0
PLECOPTERA					
Chloroperlidae	9	3	0	0	3
Perlodidae	3	0	2	1	1
Isoperla	2	0	1	0	3
Plecoptera immature	3	5	2	2	2
TRICHOPTERA					
Hydropsychidae	4	3	2	3	3
Arctopsyche	1	0	0	0	7
TERRESTRIAL INSECTS	1	0	0	0	0
COELENTERATA	302	288	124	167	173
NEMATODA	40	32	40	36	8

POLLUTION CONTROL DIVISION — Sept. 27, 1988

PEACE RIVER - 0.25 KM UPSTREAM OF CLEAR RIVER (LEFT BANK) — 08AL07FD105C

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	102	181	271	344	298
Naididae	17	19	72	49	110
Tubificidae	6	3	20	9	4
ARTHROPODA					
CRUSTACEA					
CLADOCERA					
Daphnidae	1	0	1	3	2
Bosminidae	0	0	0	0	1
COPEPODA	0	1	0	0	0
Cyclopoida	2	6	2	7	3
Harpacticoida	0	0	0	0	1
Calanoida	26	3	15	11	18
OSTRACODA	0	1	1	0	0
INSECTA					
DIPTERA					
Chironomidae					
Chironomini	1	2	1	3	3
Orthocladiinae	134	38	54	75	80
Tanypodinae	0	0	0	0	1
Tanytarsini	1	44	55	56	23
Dolichopodidae	0	1	1	0	0
Empididae					
Hemerodromia	0	1	0	0	0
Muscidae	1	0	0	0	0
Tipulidae	0	2	0	0	0
EPHEMEROPTERA					
Baetidae	0	0	0	1	
Caenidae	0	0	1	0	0
PLECOPTERA	1	0	0	0	0
Taeniopterygidae	0	1	0	0	0
TERRESTRIAL INSECTS	0	0	1	0	0
COELENTERATA					
HYDROZOA					
HYDROIDEA					
Hydridae	20	0	10	0	14
NEMATODA	154	220	166	850	749

POLLUTION CONTROL DIVISION — May 27, 1987

PEACE RIVER - 0.25 KM UPSTREAM OF CLEAR RIVER (RIGHT BANK) — 00AL07FD1100

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	5	23	6	15	7
Naididae	7	3	0	4	6
ARTHROPODA					
ARACHNOIDA					
ACARI	2	1	0	1	0
ARANEA	0	0	1	0	0
CRUSTACEA					
CLADOCERA					
Daphniidae					
Daphnia	1	2	1	0	2
COPEPODA					
Cyclopoida	31	41	29	52	17
Calanoida	26	20	18	25	26
OSTRACODA	1	1	0	0	0
INSECTA					
COLLEMBOLA	0	0	2	1	1
DIPTERA					
Athericidae					
Atherix	0	0	0	0	1
Ceratopogonidae	1	0	0	1	0
Chironomidae					
Chironomidae pupae	2	0	0	0	1
Chironomini	5	7	3	10	14
Diamesinae	1	0	0	0	0
Orthocladiinae	11	8	10	16	11
Tanypodinae	4	0	0	2	3
Tanytarsini	3	0	2	0	0
Empididae					
Chelifera	0	0	1	0	0
Simuliidae	1	2	1	7	1
Diptera pupae	3	0	0	0	3
Diptera adults	0	0	0	1	0
EPHEMEROPTERA					
Baetidae	2	1	0	0	1
Baetis	1	3	1	2	0
Ephemerellidae					
Ephemerella	13	5	3	19	9
Heptageniidae					
Rhithrogena	0	0	1	0	0
Leptophlebiidae	0	0	1	0	0
Siphlonuridae	0	0	1	0	0
PLECOPTERA					
Chloroperlidae	1	0	0	0	0
Suwallia complex	0	0	0	3	0
Nemouridae					
Podmosta	0	1	0	1	0
Perlodidae	1	0	0	2	3
Isogenoides	0	0	0	2	0
Isoperla	0	0	0	1	1
TRICHOPTERA					
Hydropsychidae					
Hydropsyche	0	0	0	1	0
Hydroptilidae					
Hydroptila	0	0	1	0	0
COELENTERATA	1	1	0	1	3
NEMATODA	1	2	1	2	5

POLLUTION CONTROL DIVISION — Sept. 28, 1987

PEACE RIVER - 0.25 KM UPSTREAM OF CLEAR RIVER (RIGHT BANK) — 00AL07FD1100

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	7	30	7	0	18
Naididae	1	8	6	1	1
Tubificidae	1	1	0	1	0
ARTHROPODA					
ARACHNOIDA					
ACARI	20	11	18	6	11
CRUSTACEA					
CLADOCERA					
Daphniidae					
Daphnia	1	1	3	1	0
COPEPODA					
Cyclopoida	5	2	3	0	0
Harpacticoida	0	2	0	0	0
Calanoida	11	27	18	27	10
OSTRACODA	1	1	0	0	0
INSECTA					
DIPTERA					
Athericidae					
Atherix	0	0	1	0	0
Ceratopogonidae	0	0	1	0	0
Chironomidae					
Chironomidae pupae	0	0	1	0	1
Chironomini	0	10	3	1	0
Orthocladiinae	32	21	16	22	36
Tanypodinae	0	2	5	0	2
Tanytarsini	0	0	0	1	0
Empididae					
Hemerodromia	2	2	0	0	1
Tenyderidae	1	0	0	0	0
Tipulidae					
Limnophila	0	1	0	0	0
EPHEMEROPTERA					
Baetidae	1	2	3	1	0
Baetis	1	0	0	0	0
Ephemerellidae					
Ephemerella	13	12	14	8	13
Heptageniidae	3	3	8	10	6
Heptagenia	1	2	0	2	1
Rhithrogena	0	1	2	4	3
Tricorythidae					
Tricorythodes	1	0	0	0	0
HEMIPTERA					
Corixidae	1	0	0	1	1
PLECOPTERA					
Capnidae	12	14	13	20	28
Chloroperlidae	1	6	8	3	4
Perlodidae	13	15	20	4	9
Isogenoides	10	15	19	10	0
Pteronarcyidae					
Pteronarcella	0	2	3	2	1
Taeniopterygidae					
Oemopteryx	28	51	55	8	6
TRICHOPTERA					
Brachycentridae					
Brachycentrus	0	1	2	0	0
Hydropsychidae	2	4	4	0	1
Arctopsyche	0	4	3	0	6
Cheumatopsyche	0	6	9	2	3
Hydropsyche	3	14	16	0	0
Leptoceridae					
Oecetis	1	0	0	0	0
COELENTERATA	92	94	383	34	156
NEMATODA	4	2	1	1	1

POLLUTION CONTROL DIVISION — July 21, 1988

PEACE RIVER - 0.25 KM UPSTREAM OF CLEAR RIVER (RIGHT BANK) — 00AL07FD1100

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	29	60	24	51	30
Naididae	2	5	5	6	8
Tubificidae	0	0	0	1	0
ARTHROPODA					
ARACHNOIDA					
ACARI	0	5	2	3	2
CRUSTACEA					
CLADOCERA					
Daphnidae					
Daphnia	171	93	104	127	97
Bosminidae					
Bosmina	2	0	3	1	1
COPEPODA					
Cyclopoida	64	37	52	65	42
Calanoida	160	138	164	160	142
INSECTA					
COLEOPTERA	0	1	0	0	0
Hydrophilidae	0	1	0	0	0
DIPTERA					
Chironomidae					
Chironomidae pupae	0	1	1	1	1
Chironomini	5	6	32	21	8
Orthocladiinae	6	13	6	9	6
Tanypodinae	2	2	1	0	1
Tanytarsini	1	1	0	0	0
Empididae					
Chelifera	1	0	0	0	0
Hemerodromia	0	0	0	2	0
Tanyderidae	0	1	0	0	0
Diptera pupae	1	0	0	0	1
Diptera adults	1	0	1	0	2
EPHEMEROPTERA					
Baetidae	1	4	4	5	1
Baetis	5	0	2	5	4
Ephemerellidae	0	0	0	0	1
Ephemerella	0	2	1	3	2
Heptageniidae	6	10	5	3	3
Heptagenia	3	0	1	1	3
Rhithrogena	1	0	1	3	0
Leptophlebiidae	1	0	1	0	0
Paraleptophlebia	1	0	0	0	0
Siphlonuridae	0	0	1	0	1
PLECOPTERA					
Capniidae	1	1	1	0	0
Chloroperlidae	5	4	7	5	2
Perlodidae	9	7	5	6	2
Isogenoides	0	6	1	2	2
Isoperla	0	0	2	1	1
Taeniopterygidae	5	4	7	2	2
TRICHOPTERA					
Hydropsychidae	6	3	1	6	2
Arctopsyche	2	4	3	1	0
COELENTERATA	191	239	141	194	172
NEMATODA	5	11	12	14	8

POLLUTION CONTROL DIVISION — Sept. 27, 1988

PEACE RIVER - 0.25 KM UPSTREAM OF CLEAR RIVER (RIGHT BANK) — 00AL07FD1100

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	8	7	12	3	6
Naididae	14	68	36	1	16
Tubificidae	1	0	1	0	0
ARTHROPODA					
CRUSTACEA					
CLADOCERA					
Daphnidae	2	2	1	1	1
Bosminidae	3	3	2	1	0
Chydoridae	0	1	0	1	0
COPEPODA					
Cyclopoida	13	20	14	38	12
Harpacticoida	1	5	2	44	5
Calanoida	15	37	31	22	8
INSECTA					
DIPTERA					
Ceratopogonidae	0	1	0	0	0
Chironomidae					
Chironomini	0	0	3	2	0
Orthocladiinae	1	4	2	2	2
Tanypodinae	0	0	0	1	0
Tanytarsini	1	18	11	11	1
Simuliidae	0	1	0	0	0
EPHEMEROPTERA					
Baetidae					
Baetis	0	0	1	0	0
Ephemerellidae					
Ephemerella	0	0	0	1	0
Heptageniidae	0	4	2	1	1
Heptagenia	0	0	1	0	0
Rhithrogena	0	2	0	1	0
Siphlonuridae					
Ameletus	0	0	0	0	1
HEMIPTERA					
Corixidae	0	0	1	0	0
PLECOPTERA	1	4	1	0	1
Capniidae	9	10	11	10	6
Chloroperlidae	0	2	0	0	1
Perlodidae	1	0	1	1	0
Taeniopterygidae	1	4	4	7	3
TRICHOPTERA					
Trichoptera immatures	0	1	0	0	0
COELENTERATA					
HYDROZOA					
HYDROIDEA					
Hydridae	81	137	87	11	22
NEMATODA	2	8	6	5	2
TARDIGRADA	0	0	1	0	0

POLLUTION CONTROL DIVISION — Sept. 27, 1988

PEACE RIVER - DUNVEGAN (LEFT) — 00AL07FD1500

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	59	96	116	111	121
Naididae	174	182	89	44	59
Tubificidae	0	1	4	0	3
ARTHROPODA					
ARACHNOIDA					
ACARI	0	0	3	0	0
CRUSTACEA					
CLADOCERA					
Daphnidae	0	1	0	2	0
Bosminidae	2	0	2	0	0
Chydoridae	0	0	2	0	0
COPEPODA					
Cyclopoida	13	3	4	4	0
Calanoida	13	11	19	9	6
OSTRACODA	0	0	0	2	1
INSECTA					
DIPTERA					
Chironomidae					
Chironomidae pupae	1	0	1	0	1
Chironomini	9	2	5	2	1
Orthocladiinae	24	24	31	9	11
Tanypodinae	1	0	0	0	0
Tanytarsini	39	21	28	3	5
Tanyderidae					
Protanyderus	0	0	0	1	0
Tipulidae	1	0	0	0	0
EPHEMEROPTERA					
Ephemerellidae					
Ephemerella	4	0	1	0	2
Heptageniidae	6	5	7	5	[illegible]
Heptagenia	3	1	0	1	[illegible]
Rhithrogena	1	0	2	0	[illegible]
PLECOPTERA	3	2	1	1	[illegible]
Capnidae	16	21	31	18	[illegible]
Perlodidae	5	1	1	1	[illegible]
Isogenoides	2	0	0	0	[illegible]
Taeniopterygidae	14	0	1	0	[illegible]
COELENTERATA					
HYDROZOA					
HYDROIDEA					
Hydridae	28	27	25	36	42
NEMATODA	15	27	31	25	34

POLLUTION CONTROL DIVISION — Oct. 5, 1988

PEACE RIVER - ABOVE SMOKY RIVER — 00AL07FD4500

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	26	38	20	33	36
Naididae	586	508	364	264	200
Tubificidae	1086	356	122	132	205
ARTHROPODA					
CRUSTACEA					
CLADOCERA					
Daphnidae					
Daphnia	1	0	0	0	2
COPEPODA					
Cyclopoida	2	0	2	0	2
Calanoida	1	0	0	0	1
INSECTA					
DIPTERA					
Chironomidae					
Chironomidae pupae	0	0	0	1	0
Chironomini	41	11	13	0	0
Diamesinae	0	1	1	0	0
Orthocladiinae	17	6	8	5	3
Tanypodinae	4	0	0	0	0
Tanytarsini	56	7	16	4	4
Prodiamesinae	13	5	6	0	0
Dolichopodidae	0	1	0	0	1
Tipulidae	0	0	3	0	0
EPHEMEROPTERA					
Heptageniidae	0	0	0	1	0
Rhithrogena	1	0	0	0	0
HEMIPTERA					
Corixidae	21	20	7	25	44
PLECOPTERA					
Capnidae	6	0	1	1	0
Perlodidae	2	0	1	0	0
Isoperla	2	0	1	1	0
Plecoptera immature	1	0	0	0	0
TRICHOPTERA					
Hydropsychidae					
Cheumatopsyche	1	0	0	0	0
COELENTERATA	21	5	0	6	7
NEMATODA	36	47	32	16	2[illegible]

POLLUTION CONTROL DIVISION — July 27, 1986

PEACE RIVER - (B1R) 4 KM U/S DAISHOWA PULPMILL — 00AL07HA2100

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	0	0	1	0	[illegible]
Naididae	1	10	1	3	8
Tubificidae	77	110	46	58	62
ARTHROPODA					
CRUSTACEA					
CLADOCERA					
Daphniidae					
Daphnia	1	0	0	1	0
COPEPODA					
Cyclopoida	1	0	2	0	0
Calanoida	0	0	3	1	1
INSECTA					
DIPTERA					
Ceratopogonidae	0	0	0	0	1
Chironomidae					
Chironomidae pupae	1	0	0	0	1
Chironomini	7	2	9	11	[illegible]
Orthocladiinae	4	3	1	1	[illegible]
Tanypodinae	0	1	0	0	[illegible]
Tanytarsini	0	1	3	4	4
EPHEMEROPTERA					
Baetidae	0	0	0	4	2
Caenidae					
Caenis	0	0	0	1	0
Tricorythidae					
Tricorythodes	0	0	0	0	1
TRICHOPTERA					
Hydropsychidae	1	0	0	0	0
TERRESTRIAL INSECTS	0	0	0	1	0
COELENTERATA	13	13	12	12	16
NEMATODA	27	20	10	12	14

POLLUTION CONTROL DIVISION — Oct. 4, 1988

PEACE RIVER - (B1R) 4 KM U/S DAISHOWA PULPMILL — 00AL07HA2103

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	96	41	70	76	39
Naididae	1446	868	587	585	399
Tubificidae	41	40	19	17	13
ARTHROPODA					
ARACHNOIDA					
ACARI	1	0	0	2	1
CRUSTACEA					
COPEPODA					
Cyclopoida	0	1	0	1	0
Calanoida	0	0	1	0	1
INSECTA					
DIPTERA					
Ceratopogonidae	1	0	0	0	3
Chironomidae					
Chironomidae pupae	0	0	16	4	0
Chironomini	244	37	104	168	44
Diamesinae	0	1	0	0	0
Orthocladiinae	78	24	102	158	20
Tanypodinae	5	7	20	10	0
Tanytarsini	119	24	165	154	28
Prodiamesinae	5	0	0	0	0
Empididae					
Hemerodromia	1	1	5	3	0
EPHEMEROPTERA					
Baetidae	2	1	1	2	3
Ephemerellidae	0	0	2	0	0
Ephemerella	0	0	3	4	3
Heptageniidae	2	0	2	2	0
Heptagenia	1	1	7	1	0
Rhithrogena	0	0	2	0	0
Stenonema	0	0	2	0	0
Ephemeroptera immatures	1	0	0	0	0
HEMIPTERA					
Corixidae	0	1	0	0	0
PLECOPTERA					
Capniidae	6	0	9	1	1
Perlodidae	2	1	0	0	0
Isogenoides	0	0	0	1	0
Isoperla	15	17	18	13	11
Taeniopterygidae	1	0	0	0	0
Doncopteryx	1	4	7	7	4
Plecoptera immature	0	0	0	0	1
TRICHOPTERA					
Brachycentridae					
Brachycentrus	1	1	0	0	0
Hydropsychidae	1	0	0	0	0
Hydroptilidae	0	0	0	0	1
COELENTERATA	1	1	1	3	1
NEMATODA	51	33	71	50	64

POLLUTION CONTROL DIVISION — July 27, 1988

PEACE RIVER - (B1L) 3 KM U/S DAISHOWA PULPMILL — 00AL07HA2150

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	4	10	0	5	6
Naididae	25	1	0	9	9
Tubificidae	3	8	0	5	1
ARTHROPODA					
CRUSTACEA					
CLADOCERA					
Daphniidae					
Daphnia	1	4	4	2	5
COPEPODA					
Cyclopoida	0	0	1	1	1
Calanoida	7	4	13	9	4
INSECTA					
DIPTERA					
Chironomidae					
Chironomini	13	11	3	4	6
Orthocladiinae	1	2	0	12	
Tanypodinae	1	0	0	2	1
Tanytarsini	0	1	1	0	1
Prodiamesinae	0	1	1	1	0
EPHEMEROPTERA					
Baetidae					
Baetis	0	1	0	0	0
Ephemerellidae					
Ephemerella	0	0	1	0	0
Heptageniidae	0	0	0	1	0
PLECOPTERA					
Perlodidae					
Isogenoides	0	1	0	0	0
TRICHOPTERA					
Brachycentridae					
Brachycentrus	0	0	0	0	1
Trichoptera immatures	0	0	0	0	2
NEMATODA	4	2	4	4	7

POLLUTION CONTROL DIVISION — Oct. 4, 1988

PEACE RIVER - (B1L) 3 KM U/S DAISHOWA PULPMILL — 00AL07HA2150

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	128	29	48	42	47
Naididae	264	43	30	51	83
Tubificidae	72	18	9	2	6
ARTHROPODA					
ARACHNOIDA					
ACARI	1	0	1	2	2
CRUSTACEA					
COPEPODA					
Cyclopoida	0	1	2	0	1
Calanoida	2	1	8	5	3
INSECTA					
COLLEMBOLA	0	0	0	1	0
DIPTERA					
Ceratopogonidae	0	1	0	1	0
Chironomidae					
Chironomidae pupae	8	4	0	8	4
Chironomini	32	48	13	16	41
Diamesinae	8	0	0	0	0
Orthocladiinae	103	136	104	128	124
Tanypodinae	4	28	75	87	33
Tanytarsini	671	469	544	758	730
Prodiamesinae	0	8	2	12	17
Empididae					
Hemerodromia	0	2	4	2	3
Tipulidae	0	0	0	1	0
EPHEMEROPTERA					
Baetidae	1	1	0	0	0
Ephemerellidae					
Ephemerella	4	10	2	1	4
Heptageniidae	8	30	46	21	37
Heptagenia	12	17	6	11	0
Rhithrogena	0	9	3	8	2
HEMIPTERA					
Corixidae	19	4	4	5	7
PLECOPTERA					
Capniidae	7	11	15	10	8
Chloroperlidae	0	1	0	0	1
Perlodidae	23	103	75	45	57
Isogenoides	0	2	4	2	2
Isoperla	57	109	87	142	63
Taeniopterygidae					
Doncopteryx	4	41	19	42	7
Plecoptera immature	0	2	0	1	1
TRICHOPTERA					
Brachycentridae					
Brachycentrus	0	0	0	1	2
Hydropsychidae					
Cheumatopsyche	0	0	3	2	0
Hydropsyche	2	5	7	7	2
COELENTERATA	44	28	33	35	28
NEMATODA	46	62	59	61	33

POLLUTION CONTROL DIVISION — July 26, 1988

PEACE RIVER - (82R) 2 KM D/S DAISHOWA PULPMILL — 00AL07HA220C

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	1	1	2	3	2
Naididae	5	3	5	4	3
Tubificidae	12	6	5	22	21
ARTHROPODA					
ARACHNOIDA					
ACARI	0	1	1	2	0
CRUSTACEA					
CLADOCERA					
Daphnidae					
Daphnia	4	1	1	7	1
COPEPODA					
Cyclopoida	3	5	2	7	[illegible]
Calanoida	0	0	3	3	4
INSECTA					
DIPTERA					
Ceratopogonidae	0	0	0	2	0
Chironomidae					
Chironomidae pupae	1	3	3	3	2
Chironomini	7	4	24	34	6
Orthocladiinae	11	4	8	10	2
Tanypodinae	2	2	5	2	2
Tanytarsini	35	47	63	41	25
Empididae					
Hemerodromia	0	0	1	1	0
EPHEMEROPTERA					
Baetidae	0	0	3	1	0
Ephemerellidae					
Ephemerella	0	1	2	1	0
Heptageniidae	9	6	11	12	3
Heptagenia	2	0	14	8	2
Siphlonuridae					
Ameletus	3	1	1	1	0
PLECOPTERA					
Capniidae	0	1	0	3	1
Chloroperlidae	1	0	0	1	0
Perlidae					
Claassenia sabulosa	1	0	0	0	0
Perlodidae	6	0	15	13	5
Isogenoides	0	0	0	1	2
Isoperla	0	0	1	0	0
TRICHOPTERA					
Hydropsychidae	15	5	5	11	4
Hydropsyche	13	5	14	14	6
Trichoptera immatures	0	0	0	1	0
COELENTERATA	68	40	117	123	35
NEMATODA	5	4	2	19	9

POLLUTION CONTROL DIVISION — Oct. 4, 1988

PEACE RIVER - (82R) 2 KM D/S DAISHOWA PULPMILL — 00AL07HA220C

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	24	32	40	11	32
Naididae	696	318	671	74	932
Tubificidae	13	46	12	6	16
ARTHROPODA					
ARACHNOIDA					
ACARI	0	1	0	1	0
CRUSTACEA					
CLADOCERA					
Bosminidae					
Bosmina	0	0	0	4	0
COPEPODA					
Harpacticoida	3	0	1	0	0
Calanoida	1	2	1	3	0
INSECTA					
COLEOPTERA	0	0	0	0	1
DIPTERA					
Chironomidae					
Chironomidae pupae	4	4	4	12	0
Chironomini	231	111	611	135	593
Orthocladiinae	96	66	56	88	76
Tanypodinae	12	37	0	20	24
Tanytarsini	396	269	224	280	208
Prodiamesinae	0	0	0	8	0
Empididae					
Hemerodromia	1	1	1	4	1
Diptera adults	0	0	1	0	1
EPHEMEROPTERA					
Baetidae	4	1	0	4	1
Baetis	0	0	0	0	1
Ephemerellidae					
Ephemerella	6	2	8	7	12
Heptageniidae	2	2	0	2	4
Heptagenia	2	0	0	0	0
Rhithrogena	0	0	0	0	1
Ephemeroptera immatures	0	0	0	1	0
HEMIPTERA					
Corixidae	4	0	2	2	2
PLECOPTERA					
Capniidae	5	5	0	6	9
Chloroperlidae	2	0	0	0	0
Plecoptera immature	0	1	0	0	1
Perlodidae	28	20	4	17	18
Isogenoides	1	0	1	1	0
Isoperla	80	26	10	26	63
Taeniopterygidae					
Oemopteryx	7	7	3	4	4
TRICHOPTERA					
Brachycentridae					
Brachycentrus	0	1	0	0	0
Hydropsychidae	0	2	0	2	2
Cheumatopsyche	5	9	0	13	2
Hydropsyche	6	14	1	27	5
TERRESTRIAL INSECTS	0	0	1	0	0
COELENTERATA	4	11	2	17	5
MOLLUSCA	0	0	1	0	2
NEMATODA	10	20	25	31	23
PLATYHELMINTHES					
TURBELLARIA	1	0	0	0	0
TARDIGRADA	1	0	0	0	0

POLLUTION CONTROL DIVISION — July 27, 1988

PEACE RIVER - (82L) 5 KM D/S DAISHOWA SITE — 00AL07HA2600

ANNELIDA			
OLIGOCHAETA			
HAPLOTAXIDA			
Enchytraeidae	6	2	47
Naididae	3	12	4
Tubificidae	126	34	0
ARTHROPODA			
CRUSTACEA			
CLADOCERA			
Daphnidae			
Daphnia	3	5	2
COPEPODA			
Cyclopoida	2	0	1
Calanoida	10	7	7
INSECTA			
DIPTERA			
Ceratopogonidae	0	0	1
Chironomidae			
Chironomidae pupae	2	0	0
Chironomini	4	45	7
Orthocladiinae	0	1	0
Tanypodinae	1	2	0
Tanytarsini	0	0	1
Diptera adults	0	0	1
EPHEMEROPTERA			
Ephemerellidae			
Ephemerella	0	0	1
Heptageniidae			
Heptagenia	1	2	4
PLECOPTERA			
Perlodidae	1	0	5
Isogenoides	0	0	2
Chloroperlidae			
Suwallia complex	1	0	2
TRICHOPTERA			
Hydropsychidae	1	2	0
Trichoptera immatures	1	0	0
COELENTERATA	152	228	172
NEMATODA	7	8	9

POLLUTION CONTROL DIVISION — Oct. 4, 1988

PEACE RIVER - (82L) 5 KM D/S DAISHOWA SITE — 00AL07HA2600

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	40	65	81	81	61
Naididae	15	38	22	43	42
Tubificidae	3	8	3	0	1
ARTHROPODA					
ARACHNOIDA					
ACARI	1	3	2	2	0
CRUSTACEA					
CLADOCERA					
Bosminidae					
Bosmina	0	0	1	1	0
Chydoridae	0	0	0	0	1
COPEPODA					
Cyclopoida	4	4	3	3	3
Calanoida	4	1	4	6	1
INSECTA					
DIPTERA					
Chironomidae					
Chironomidae pupae	3	1	0	3	1
Chironomini	18	7	11	23	20
Orthocladiinae	73	110	118	97	97
Tanypodinae	6	8	24	20	13
Tanytarsini	103	200	172	155	183
Prodiamesinae	0	1	0	0	0
Empididae					
Hemerodromia	2	1	0	3	3
Tipulidae	0	0	0	1	0
Diptera adults	1	0	0	0	0
EPHEMEROPTERA					
Baetidae	3	1	4	3	0
Ephemerellidae					
Ephemerella	7	6	9	8	10
Heptageniidae	4	12	29	27	13
Rhithrogena	2	6	11	13	22
HEMIPTERA					
Corixidae	0	0	0	0	1
PLECOPTERA					
Capniidae	4	3	16	7	11
Chloroperlidae	0	1	3	0	1
Perlodidae	77	193	268	262	257
Isogenoides	1	1	6	4	7
Isoperla	28	45	61	64	99
Taeniopterygidae					
Doncopteryx	22	55	77	47	65
Plecoptera immature	3	3	3	0	0
TRICHOPTERA					
Brachycentridae					
Brachycentrus	1	0	1	0	0
Hydropsychidae	1	3	5	0	3
Cheumatopsyche	9	3	1	0	0
Hydropsyche	1	4	4	6	7
COELENTERATA	5	9	34	18	13
NEMATODA	38	14	39	44	44
PLATYHELMINTHES					
TURBELLARIA	0	1	0	0	0

POLLUTION CONTROL DIVISION — July 27, 1988

PEACE RIVER - (82C) 7 KM DOWNSTREAM OF DAISHOWA PULPMILL — 08AL07HA0020

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	7	10	12	19	19
Naididae	1	0	0	2	0
ARTHROPODA					
ARACHNIDIDA					
ACARI	0	0	2	0	0
CRUSTACEA					
CLADOCERA					
Daphnidae					
Daphnia	45	5	48	20	33
COPEPODA					
Cyclopoida	0	0	5	11	7
Calanoida	41	47	46	28	31
OSTRACODA	1	0	0	0	0
INSECTA					
DIPTERA					
Chironomidae					
Chironomidae pupae	6	5	3	2	7
Chironomini	6	12	9	8	7
Orthocladiinae	1	5	1	1	1
Tanytarsini	7	10	14	10	21
Tipulidae	0	0	1	0	0
EPHEMEROPTERA					
Baetidae	2	1	0	0	0
Heptageniidae	7	16	5	12	4
Heptagenia	0	0	0	1	0
Rhithrogena	2	3	3	1	0
Tricorythidae					
Tricorythodes	0	0	0	0	1
PLECOPTERA					
Chloroperlidae	0	1	0	0	1
Perlidae					
Claassenia sabulosa	0	1	0	0	0
Perlodidae	13	22	5	13	6
Isogenoides	3	3	1	3	1
Isoperla	0	1	0	0	0
Taeniopterygidae	0	1	1	0	0
TRICHOPTERA					
Brachycentridae					
Brachycentrus	1	1	2	1	1
Hydropsychidae	0	1	0	2	0
Hydropsyche	2	2	0	0	0
TERRESTRIAL INSECTS	0	0	1	0	0
COELENTERATA	123	111	88	87	57
NEMATODA	2	3	3	2	2

POLLUTION CONTROL DIVISION — Oct. 4, 1988

PEACE RIVER - (82C) 7 KM DOWNSTREAM OF DAISHOWA PULPMILL — 08AL07HA0020

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	80	2	34	46	33
Naididae	17	45	111	31	7
Tubificidae	0	7	0	0	0
ARTHROPODA					
ARACHNIDIDA					
ACARI	2	0	1	0	1
CRUSTACEA					
CLADOCERA					
Daphnidae					
Daphnia	0	0	0	0	1
Bosminidae					
Bosmina	0	1	0	1	0
COPEPODA					
Cyclopoida	2	2	2	3	2
Harpacticoida	0	1	0	0	0
Calanoida	2	4	1	4	4
INSECTA					
DIPTERA					
Chironomidae					
Chironomidae pupae	3	1	0	0	0
Chironomini	22	6	11	13	13
Orthocladiinae	94	33	70	39	61
Tanypodinae	2	1	0	2	1
Tanytarsini	22	7	14	5	9
EPHEMEROPTERA					
Baetidae	2	0	0	2	1
Ephemerellidae					
Ephemerella	6	0	6	4	6
Heptageniidae	7	4	5	1	4
Heptagenia	1	0	0	0	0
Rhithrogena	0	2	0	1	1
PLECOPTERA					
Capniidae	5	0	0	3	4
Perlodidae	16	21	85	37	59
Isogenoides	1	0	0	0	2
Isoperla	15	9	12	9	12
Taeniopterygidae					
Oemopteryx	19	1	24	6	26
Plecoptera immature	1	0	0	0	1
TRICHOPTERA					
Hydropsychidae					
Hydropsyche	0	0	1	0	3
COELENTERATA	8	15	15	14	6
NEMATODA	24	9	12	10	13

POLLUTION CONTROL DIVISION — July 26, 1980

PEACE RIVER - (83L) 17 KM D/S DAISHOWA PULPMILL — 00ALBTHA2041

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	25	20	82	52	41
Naididae	1	1	3	0	1
ARTHROPODA					
CRUSTACEA					
CLADOCERA					
Daphniidae					
Daphnia	1	3	1	0	3
COPEPODA					
Cyclopoida	3	1	0	4	1
Harpacticoida	2	1	22	1	1
Calanoida	9	3	1	3	0
OSTRACODA	2	0	1	2	0
INSECTA					
DIPTERA					
Chironomidae					
Chironomidae pupae	2	3	3	5	7
Chironomini	0	6	21	3	0
Orthocladiinae	0	4	8	3	1
Tanypodinae	1	0	1	0	1
Tanytarsini	14	12	17	13	18
Empididae					
Hemerodromia	1	1	0	0	0
EPHEMEROPTERA					
Baetidae					
Baetis	0	0	1	0	0
Ephemerellidae	1	0	0	0	0
Ephemerella	0	0	0	0	1
Heptageniidae	0	1	1	1	2
Heptagenia	0	0	1	0	0
PLECOPTERA					
Perlodidae	21	21	22	12	0
Isogenoides	1	1	1	2	4
Isoperla	0	0	2	0	0
Plecoptera immature	0	0	0	1	0
TRICHOPTERA					
Brachycentridae					
Brachycentrus	1	0	0	1	0
Hydropsychidae	4	3	6	2	1
Cheumatopsyche	0	0	2	0	2
Hydropsyche	9	8	10	6	9
COELENTERATA	57	73	158	82	110
NEMATODA	0	1	2	2	2

POLLUTION CONTROL DIVISION — Oct. 4, 1980

PEACE RIVER - (83L) 17 KM D/S DAISHOWA PULPMILL — 00ALBTHA2043

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	120	24	55	41	86
Lumbriculidae	0	1	0	0	0
Naididae	39	1	32	10	11
ARTHROPODA					
ARACHNOIDA					
ACARI	6	2	3	1	2
CRUSTACEA					
CLADOCERA					
Bosminidae					
Bosmina	0	1	4	3	2
COPEPODA					
Cyclopoida	3	2	1	1	3
Harpacticoida	2	0	1	0	1
Calanoida	0	9	2	6	1
INSECTA					
DIPTERA					
Chironomidae					
Chironomidae pupae	8	0	0	4	[illegible]
Chironomini	24	16	20	[illegible]	[illegible]
Orthocladiinae	140	92	104	[illegible]	[illegible]
Tanypodinae	21	9	16	[illegible]	[illegible]
Tanytarsini	497	300	484	[illegible]	[illegible]
Probezzeinae	0	0	4	0	0
Empididae					
Hemerodromia	0	1	0	0	0
Diptera adults	1	0	0	0	0
EPHEMEROPTERA					
Baetidae	4	2	2	0	1
Ephemerellidae					
Ephemerella	2	2	4	[illegible]	[illegible]
Heptageniidae	35	31	55	50	[illegible]
Heptagenia	4	[illegible]	8	[illegible]	[illegible]
Rhithrogena	12	21	1	38	[illegible]
Stenonema	0	0	0	1	[illegible]
HEMIPTERA					
Corixidae	0	0	1	0	0
PLECOPTERA					
Capniidae	17	16	15	24	9
Chloroperlidae	0	0	0	1	1
Perlodidae	166	101	125	113	71
Isogenoides	0	0	1	0	0
Isoperla	102	86	69	74	[illegible]
Taeniopterygidae	0	0	0	0	0
Oemopteryx	41	31	12	36	[illegible]
Plecoptera immature	3	1	0	0	0
TRICHOPTERA					
Hydropsychidae	1	0	1	0	0
Cheumatopsyche	0	1	1	4	1
Hydropsyche	1	2	6	2	0
COELENTERATA	44	11	45	59	16
NEMATODA	51	18	33	23	35

POLLUTION CONTROL DIVISION — July 28, 1988

PEACE RIVER - (83R) 20 KM D/S DAISHOWA PULPMILL — 08AL07HA2661

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	10	5	18	4	15
Naididae	2	1	10	5	1
Tubificidae	0	1	4	1	1
ARTHROPODA					
ARACHNOIDA					
ACARI	0	0	2	2	0
CRUSTACEA					
CLADOCERA					
Daphniidae					
Daphnia	0	0	1	1	2
COPEPODA					
Calanoida	0	0	3	5	9
INSECTA					
DIPTERA					
Ceratopogonidae	0	0	1	0	0
Chironomidae					
Chironomidae pupae	5	0	4	0	2
Chironomini	2	11	14	3	7
Orthocladiinae	2	3	11	2	1
Tanypodinae	0	0	1	0	1
Tanytarsini	29	34	28	18	31
EPHEMEROPTERA					
Baetidae	0	1	4	1	2
Baetis	0	2	1	0	2
Heptageniidae	5	16	12	11	9
Cinygmula	0	2	0	0	6
Heptagenia	0	0	1	1	0
Rhithrogena	11	34	27	15	11
PLECOPTERA					
Capniidae	0	0	1	0	0
Chloroperlidae	1	1	0	0	0
Nemouridae					
Malenka	0	0	0	1	0
Perlidae	0	1	0	1	0
Claassenia sabulosa	0	0	1	0	0
Perlodidae	23	41	76	22	20
Isogenoides	1	2	6	3	3
Isoperla	0	1	2	1	1
Taeniopterygidae	1	0	1	0	3
TRICHOPTERA					
Brachycentridae					
Brachycentrus	0	2	0	0	0
Glossosomatidae					
Glossosoma	0	0	0	1	1
Hydropsychidae	2	3	10	1	3
Cheumatopsyche	0	0	1	0	3
Hydropsyche	13	15	26	4	11
Hydroptilidae					
Hydroptila	0	0	1	0	0
COELENTERATA	32	81	75	50	43
NEMATODA	0	1	9	3	5

POLLUTION CONTROL DIVISION — Oct. 4, 1988

PEACE RIVER - (83R) 20 KM D/S DAISHOWA PULPMILL — 08AL07HA2660

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	71	44	47	60	37
Naididae	150	39	11	53	36
Tubificidae	0	3	0	1	0
ARTHROPODA					
ARACHNOIDA					
ACARI	1	0	0	0	1
CRUSTACEA					
CLADOCERA					
Daphniidae					
Daphnia	1	0	1	0	0
COPEPODA					
Cyclopoida	0	1	0	0	0
Calanoida	0	0	0	1	0
INSECTA					
DIPTERA					
Chironomidae					
Chironomidae pupae	0	3	0	1	3
Chironomini	35	23	23	24	4
Orthocladiinae	32	28	32	32	15
Tanypodinae	1	2	2	1	1
Tanytarsini	28	28	16	31	16
Empididae					
Neoplasta	1	1	0	0	0
EPHEMEROPTERA					
Baetidae	0	1	0	0	0
Ephemerellidae					
Ephemerella	0	0	1	0	0
Heptageniidae	5	9	6	1	0
Heptagenia	0	1	1	1	1
Rhithrogena	1	1	1	0	1
Tricorythidae					
Tricorythodes	0	0	1	0	0
HEMIPTERA					
Corixidae	0	1	0	0	0
PLECOPTERA					
Capniidae	0	11	12	8	1
Perlodidae	2	3	3	4	4
Isoperla	1	4	2	5	1
Taeniopterygidae					
Doncopteryx	2	5	2	4	0
Plecoptera immature	1	2	0	0	0
COELENTERATA	33	22	15	14	9
NEMATODA	26	12	10	20	17

POLLUTION CONTROL DIVISION — July 26, 1988

PEACE RIVER - (B4R) 32 KM D/S DAISHOWA PULPMILL — 00AL07HA2680

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	7	25	3	15	10
Naididae	0	2	0	1	0
ARTHROPODA					
ARACHNOIDA					
ACARI	0	1	0	1	0
CRUSTACEA					
CLADOCERA					
Daphnidae					
Daphnia	1	2	3	1	4
COPEPODA					
Cyclopoida	1	6	1	2	1
Calanoida	5	11	9	10	7
INSECTA					
DIPTERA					
Chironomidae					
Chironomidae pupae	1	15	9	14	23
Chironomini	4	10	6	7	6
Orthocladiinae	1	8	4	5	3
Tanypodinae	0	1	0	0	0
Tanytarsini	3	6	12	8	16
Simuliidae	0	0	0	1	0
Tipulidae	1	0	0	0	0
EPHEMEROPTERA					
Baetidae	0	0	3	0	1
Baetis	0	1	0	0	0
Ephemerellidae	0	0	1	0	1
Ephemerella	0	1	0	0	0
Heptageniidae	1	10	7	6	1
Rhithrogena	0	7	7	7	3
PLECOPTERA					
Perlidae	0	1	0	0	0
Perlodidae	4	23	5	11	15
Isogenoides	1	2	3	2	2
Isoperla	1	3	0	0	1
Taeniopterygidae	0	0	0	0	1
TRICHOPTERA					
Brachycentridae					
Brachycentrus	0	2	1	0	0
Glossosomatidae					
Glossosoma	0	1	0	0	0
Hydropsychidae	0	0	1	0	0
Hydropsyche	0	4	2	0	3
COELENTERATA	61	118	65	80	56
NEMATODA	0	1	2	7	1

POLLUTION CONTROL DIVISION — Oct. 4, 1988

PEACE RIVER - (B4R) 32 KM D/S DAISHOWA PULPMILL — 00AL07HA2680

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	48	46	24	17	23
Naididae	4	11	11	0	10
ARTHROPODA					
ARACHNOIDA					
ACARI	6	4	13	1	2
CRUSTACEA					
CLADOCERA					
Daphnidae					
Daphnia	0	1	0	0	0
Bosminidae					
Bosmina	0	0	1	0	0
COPEPODA					
Cyclopoida	5	9	1	2	4
Calanoida	4	0	5	11	9
INSECTA					
DIPTERA					
Chironomidae					
Chironomidae pupae	4	0	8	2	5
Chironomini	122	22	45	32	26
Orthocladiinae	464	82	365	112	136
Tanypodinae	0	7	8	3	6
Tanytarsini	40	2	56	20	18
Empididae					
Hemerodromia	0	0	0	2	0
Tipulidae	1	0	0	0	1
EPHEMEROPTERA					
Baetidae	5	0	11	1	1
Ephemerellidae					
Ephemerella	2	2	8	6	9
Heptageniidae	9	4	15	6	7
Heptagenia	0	0	1	0	0
Rhithrogena	1	0	6	1	2
PLECOPTERA					
Capniidae	3	1	3	4	5
Chloroperlidae	0	0	2	0	0
Plecoptera immature	3	3	6	3	4
Perlodidae	61	34	139	52	67
Isogenoides	3	6	6	1	6
Isoperla	27	22	74	30	32
Taeniopterygidae					
Oemopteryx	61	49	105	65	98
TRICHOPTERA					
Hydropsychidae					
Hydropsyche	1	0	0	0	2
Cheumatopsyche	1	0	0	0	1
COELENTERATA	6	9	18	0	22
NEMATODA	41	55	21	48	25
PLATYHELMINTHES					
TURBELLARIA	0	0	3	0	1

POLLUTION CONTROL DIVISION — July 26, 1980

PEACE RIVER - (84C) 33 KM D/S DAISHOWA PULPMILL — 00AL07HA27CC

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	8	14	27	15	21
Naididae	1	0	0	1	2
ARTHROPODA					
ARACHNOIDA					
ACARI	1	0	0	0	0
CRUSTACEA					
CLADOCERA					
Daphniidae					
Daphnia	0	1	2	6	3
COPEPODA					
Cyclopoida	0	2	1	0	2
Calanoida	2	4	0	3	4
INSECTA					
DIPTERA					
Chironomidae					
Chironomidae pupae	4	8	13	7	2
Chironomini	23	11	15	11	12
Orthocladiinae	3	4	8	2	7
Tanytarsini	0	2	0	0	3
Tipulidae	1	1	2	0	2
Diptera adults	1	0	0	0	0
EPHEMEROPTERA					
Baetidae	0	1	2	0	6
Ephemerellidae					
Ephemerella	0	0	0	1	0
Heptageniidae	1	3	1	1	1
Rhithrogena	1	0	1	0	0
HEMIPTERA	1	0	0	0	1
PLECOPTERA					
Brachycentridae					
Brachycentrus	0	2	0	0	0
Perlodidae	3	2	0	1	2
Isogenoides	0	1	2	2	0
Isoperla	0	0	0	1	1
Taeniopterygidae	0	0	1	0	1
COELENTERATA	33	37	38	34	43
NEMATODA	0	0	1	1	0

POLLUTION CONTROL DIVISION — Oct. 4, 1980

PEACE RIVER - (84C) 33 KM D/S DAISHOWA PULPMILL — 00AL07HA27DD

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	29	19	52	12	43
Naididae	5	0	6	4	14
ARTHROPODA					
ARACHNOIDA					
ACARI	0	1	0	0	0
CRUSTACEA					
CLADOCERA					
Bosminidae					
Bosmina	0	1	0	1	0
COPEPODA					
Cyclopoida	1	1	1	6	2
Harpacticoida	1	0	0	1	0
Calanoida	2	7	4	10	6
INSECTA					
COLEOPTERA					
Curculionidae	0	1	0	0	0
DIPTERA					
Chironomidae					
Chironomini	15	9	13	10	14
Orthocladiinae	10	5	9	13	16
Tanypodinae	1	0	0	0	0
Tanytarsini	5	2	1	2	1
Empididae					
Hemerodromia	0	1	0	0	0
EPHEMEROPTERA					
Baetidae	1	1	0	3	0
Heptageniidae	14	17	22	17	35
Rhithrogena	39	23	52	42	42
Ephemerellidae					
Ephemerella	0	1	1	0	1
PLECOPTERA					
Capniidae	0	3	3	1	1
Chloroperlidae	0	3	0	0	0
Plecoptera immature	0	0	2	0	0
Perlodidae	36	15	58	31	47
Isogenoides	4	6	2	0	1
Isoperla	6	7	7	7	22
Taeniopterygidae					
Oemopteryx	14	12	15	11	19
TRICHOPTERA					
Hydropsychidae	0	0	0	1	0
Arctopsyche	0	1	0	0	3
COELENTERATA	24	7	28	15	14
NEMATODA	8	2	0	0	1
PLATYHELMINTHES					
TURBELLARIA	0	0	0	0	3

POLLUTION CONTROL DIVISION — July 20, 1988

PEACE RIVER - (84L) 35 KM D/S DAISHOWA PULPMILL — 00AL07HA2800

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	21	16	11	6	4
Naididae	7	9	16	14	15
Tubificidae	56	53	5	6	4
ARTHROPODA					
ARACHNOIDA					
ACARI	3	0	0	0	0
CRUSTACEA					
COPEPODA					
Calanoida	2	1	1	3	3
INSECTA					
DIPTERA					
Ceratopogonidae	0	0	0	0	1
Chironomidae					
Chironomidae pupae	1	3	1	1	2
Chironomini	14	27	29	21	37
Orthocladiinae	3	7	3	0	0
Tanypodinae	2	5	1	1	1
Tanytarsini	2	3	0	2	1
Prodiamesinae	2	3	0	1	1
Tipulidae	0	1	0	0	0
Diptera adults	22	6	1	5	4
EPHEMEROPTERA					
Baetidae	0	0	0	0	1
Ephemerellidae	1	0	0	0	0
Ephemerella	1	0	0	1	0
Heptageniidae	3	0	0	2	2
HEMIPTERA	0	4	0	0	1
Saldidae	2	0	0	0	0
PLECOPTERA					
Chloroperlidae					
Suwallia complex	0	0	0	1	0
Perlodidae	12	9	0	0	2
Isogenoides	2	1	0	0	0
TRICHOPTERA					
Hydropsychidae	17	31	0	3	4
Hydropsyche	0	1	0	0	0
TERRESTRIAL INSECTS	0	0	0	1	1
COELENTERATA	225	438	94	14	137
NEMATODA	6	5	1	4	10

POLLUTION CONTROL DIVISION — Oct. 4, 1988

PEACE RIVER - (84L) 35 KM D/S DAISHOWA PULPMILL — 00AL07HA2803

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	58	59	42	47	63
Naididae	54	60	34	35	44
Tubificidae	4	6	0	2	0
ARTHROPODA					
ARACHNOIDA					
ACARI	2	1	2	2	2
CRUSTACEA					
COPEPODA					
Cyclopoida	0	2	1	0	0
Harpacticoida	1	6	3	4	2
Calanoida	1	0	1	0	0
INSECTA					
DIPTERA					
Chironomidae					
Chironomidae pupae	8	0	0	4	0
Chironomini	16	4	5	12	908
Orthocladiinae	84	110	108	88	72
Tanypodinae	0	4	16	12	21
Tanytarsini	1191	1163	920	782	8
Empididae					
Chelifera	1	2	0	0	0
Hemerodromia	17	9	13	10	16
EPHEMEROPTERA					
Baetidae	2	3	1	8	10
Ephemerellidae					
Ephemerella	0	0	1	3	2
Heptageniidae	70	76	47	45	64
Heptagenia	0	0	7	2	5
Rhithrogena	14	13	9	23	7
Leptophlebiidae					
Paraleptophlebia	1	0	0	0	0
HEMIPTERA					
Corixidae	0	0	1	0	0
PLECOPTERA					
Capniidae	7	1	2	3	2
Perlodidae	70	100	80	102	42
Isoperla	18	32	40	59	77
Taeniopterygidae	11	0	0	0	0
Oemopteryx	31	80	85	112	85
Ptesiopteryx immature	2	1	0	2	3
TRICHOPTERA					
Brachycentridae					
Brachycentrus	0	0	1	0	0
Hydropsychidae	0	2	0	5	0
Cheumatopsyche	0	1	0	0	0
Hydropsyche	0	0	0	3	0
COELENTERATA	33	38	34	35	32
NEMATODA	25	26	30	21	26

POLLUTION CONTROL DIVISION — Sept. 28, 1988

PEACE RIVER - ABOVE NOTIKEWIN RIVER — 08AL07HC1200

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	25	46	85	57	44
Naididae	4	6	5	2	2
ARTHROPODA					
ARACHNOIDA					
ACARI	0	1	1	0	0
CRUSTACEA					
COPEPODA					
Cyclopoida	2	1	1	3	2
Calanoida	7	10	4	4	3
INSECTA					
DIPTERA					
Chironomidae					
Chironomidae pupae	0	0	2	0	1
Chironomini	2	2	8	1	6
Orthocladiinae	4	10	4	3	6
Tanytarsini	0	1	3	0	0
Simuliidae	1	0	0	0	0
Tanyderidae					
Protanyderus	0	0	1	0	0
EPHEMEROPTERA					
Baetidae					
Baetis	0	0	0	2	3
Ephemerellidae					
Ephemerella	1	2	2	3	1
Heptageniidae	0	3	0	4	7
Rhithrogena	3	3	2	0	5
PLECOPTERA	1	0	0	0	0
Capniidae	5	3	4	1	4
Perlodidae	30	43	47	49	46
Isogenoides	1	1	0	0	0
Taeniopterygidae	8	13	10	16	31
COELENTERATA					
HYDROZOA					
HYDROIDEA					
Hydridae	13	17	2	16	14
NEMATODA	2	1	4	2	1
PLATYHELMINTHES					
TURBELLARIA	1	0	0	0	0

POLLUTION CONTROL DIVISION — Sept. 29, 1988

PEACE RIVER - NEAR CARAJOU (CENTRE) — 08AL07HD1030

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	24	18	9	10	11
Naididae	1	2	0	5	1
ARTHROPODA					
ARACHNOIDA					
ACARI	1	0	0	2	0
CRUSTACEA					
CLADOCERA					
Daphniidae	0	1	30	0	0
Bosminidae	0	0	1	2	1
COPEPODA					
Cyclopoida	3	4	8	5	6
Calanoida	9	5	10	13	13
INSECTA					
DIPTERA					
Chironomidae					
Chironomidae pupae	1	0	0	0	1
Chironomini	30	13	15	11	15
Orthocladiinae	11	5	8	7	5
Tanypodinae	1	0	0	0	0
Tanytarsini	0	0	1	0	0
EPHEMEROPTERA					
Baetidae	0	0	1	0	0
Baetis	0	0	0	2	0
Ephemerellidae					
Ephemerella	0	2	2	3	1
Heptageniidae	8	6	6	4	3
Rhithrogena	6	11	9	11	16
PLECOPTERA	5	1	1	0	0
Capniidae	5	2	4	3	2
Perlodidae	102	88	50	49	40
Isogenoides	3	2	4	3	0
Taeniopterygidae	9	13	14	15	9
TRICHOPTERA					
Hydropsychidae	0	0	0	1	0
COELENTERATA					
HYDROZOA					
HYDROIDEA					
Hydridae	5	4	3	31	14
NEMATODA	6	6	1	1	3

POLLUTION CONTROL DIVISION — Sept. 28, 1988

PEACE RIVER - NEAR LACRETE — 00AL07HF1530

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Naididae	162	2	70	1	9
ARTHROPODA					
CRUSTACEA					
CLADOCERA					
Daphniidae	0	0	1	104	0
Bosminidae	0	0	0	1	0
COPEPODA					
Cyclopoida	2	0	1	0	2
Calanoida	0	0	3	1	0
INSECTA					
DIPTERA					
Ceratopogonidae	2	0	0	0	0
Chironomidae					
Chironomini	68	3	14	10	2
Orthocladiinae	3	0	1	0	1
EPHEMEROPTERA					
Oligoneuriidae					
Isonychia	3	0	2	0	0
PLECOPTERA	1	0	1	1	0
Perlodidae	2	1	0	3	1
Taeniopterygidae	1	1	0	0	0
COELENTERATA					
HYDROZOA					
HYDROIDEA					
Hydridae	6	1	5	2	0
NEMATODA	11	5	6	6	6

POLLUTION CONTROL DIVISION — Sept. 29, 1988

PEACE RIVER - ABOVE WOOD BUFFALO PARK — 00AL07KA2000

ANNELIDA					
OLIGOCHAETA					
HAPLOTAXIDA					
Enchytraeidae	0	1	0	0	0
Naididae	1	3	24	6	14
ARTHROPODA					
CRUSTACEA					
CLADOCERA					
Daphniidae	0	0	2	0	0
COPEPODA					
Cyclopoida	0	0	0	0	1
OSTRACODA	0	0	0	0	1
INSECTA					
DIPTERA					
Chironomidae					
Chironomini	4	4	1	3	0
Orthocladiinae	1	0	0	0	1
EPHEMEROPTERA					
Oligoneuriidae					
Isonychia	1	0	0	0	0
COELENTERATA					
HYDROZOA					
HYDROIDEA					
Hydridae	0	0	0	0	2
NEMATODA	2	2	3	5	3

POLLUTION CONTROL DIVISION — Sept. 29, 1988

PEACE RIVER - AT FORT VERMILION — 00AL07HF1700

ARTHROPODA					
CRUSTACEA					
COPEPODA					
Cyclopoida	1	0	0	2	2
Calanoida	0	0	2	1	2
OSTRACODA	5	0	0	0	0
INSECTA					
DIPTERA					
Chironomidae					
Chironomini	20	3	3	2	10
Orthocladiinae	1	5	1	1	1
EPHEMEROPTERA					
Oligoneuriidae					
Isonychia	0	2	2	1	3
PLECOPTERA					
Capniidae	1	0	0	0	3
Perlodidae	2	0	1	0	1
NEMATODA	4	6	0	10	4

POLLUTION CONTROL DIVISION — Sept. 29, 1988

PEACE RIVER - NEAR PEACE POINT (CENTRE) — 00AL07KC1000

ANNELIDA			
OLIGOCHAETA			
HAPLOTAXIDA			
Enchytraeidae	0	1	0
Naididae	11	16	20
ARTHROPODA			
CRUSTACEA			
CLADOCERA			
Daphniidae	0	0	2
Chydoridae	0	1	0
COPEPODA			
Cyclopoida	11	11	5
Calanoida	1	0	0
OSTRACODA	0	1	3
INSECTA			
DIPTERA			
Chironomidae			
Chironomini	9	13	12
Orthocladiinae	1	0	0
Tipulidae	1	0	0
PLECOPTERA			
Perlodidae	1	0	0
NEMATODA	3	2	6

Appendix XI. Water quality data for Smoky to Notikewin reach sites, 1988-1989.

Station	Code	Date D/M/Y	Temp. Deg. C 02061	pH 10301	DO mg/L 08102	Cond. uS/cm 02041	Na mg/L 11103	Cl mg/L 17203	SO4 mg/L 16306	Susp. Solid mg/L 10401	True Color RCU 02021	Tann. & Lig. mg/L 06551	Phenol mg/L 06537	DOC mg/L 06104	TOC mg/L 06005	Total P mg/L 15406	Diss. P mg/L 15103	Total NH3 mg/L 07505	NO2+NO3 mg/L 07110	TKN mg/L 07015
d/s Daishowa - left	00AL07HA2500	17/05/88	9.0		10.1	199	3.2	0.5	20.9	1690	80	1.9	0.003	9.0	9.2	1.06	0.012	0.02	0.069	3.28
		04/10/88	10.4	8.0	10.0	188	2.1	1.0	8.7	22	30	0.3	L.001	2.9	2.9	0.01	L.003	L.01	0.012	0.18
		01/03/89	-0.3	8.4	13.2	177	1.6	1.0	8.6	L.4	20	0.3	0.001	2.2	2.4	L.003	L.003	0.01	0.039	0.12
d/s Daishowa -l. centre	00AL07HA2510	17/05/88	8.9	8.6	10.0	199	3.2	0.5	21.2	1590	120	1.6	0.003	9.4	9.7	1.00	0.012	0.02	0.073	3.42
		04/10/88	10.4	8.0	10.0	191	2.4	0.9	9.2	9.6	30	0.3	L.001	3.1	3.4	0.01	L.003	L.01	0.015	0.18
		01/03/89	-0.3	8.4	13.2	177	1.6	0.9	8.6	2.3	20	0.3	0.001	2.2	2.3	L.003	L.003	0.01	0.039	0.16
d/s Daishowa - centre	00AL07HA2520	17/05/88	9.0	8.2	10.1	199	3.2	0.5	21.3	1640	80	1.5	0.004	9.0	9.5	1.14	0.010	0.02	0.072	3.04
		04/10/88	10.4	8.0	10.0	205	3.0	2.1	11.7	10.4	30	0.3	L.001	2.6	3.2	0.01	L.003	0.02	0.015	0.16
		01/03/89	-0.1	8.3	12.9	188	2.4	1.8	10.6	1.2	20	0.3	0.001	2.3	2.4	L.003	L.003	0.01	0.041	0.12
d/s Daishowa -r. centre	00AL07HA2530	17/05/88	10.0	8.4	9.8	205	3.5	0.8	19.6	1130	60	1.5	0.003	5.8	6.4	0.69	0.008	0.02	0.056	2.08
		04/10/88	10.2	8.0	10.0	242	4.9	3.3	18.0	12	30	0.4	L.001	3.2	3.2	0.02	L.003	L.01	0.006	0.24
		01/03/89	0.1	8.1	12.6	216	4.7	3.6	16.3	1.2	20	0.4	0.001	2.7	2.8	L.003	0.003	0.01	0.046	0.12
d/s Daishowa - right	00AL07HA2540	17/05/88	10.5	8.2	10.0	207	3.8	1.1	19.3	848	60	1.0	0.002	6.0	6.3	0.62	0.008	0.02	0.052	1.88
		04/10/88	10.2	8.0	10.3	263	6.2	4.3	21.7	10.8	20	0.4	L.001	3.5	3.8	0.02	L.003	0.02	0.012	0.24
		01/03/89	0.2	8.3	12.1	228	5.2	4.2	17.5	L.4	20	0.4	0.001	2.9	3.0	0.01	0.003	0.01	0.050	0.16
u/s Whitemud - left	00AL07HA2800	17/05/88	9.1	8.0	10.2	196	2.6	0.6	16.1	830	70	5.9	0.002	6.3	6.7	0.78	0.010	0.02	0.073	2.00
		04/10/88	10.5	7.8	10.4	194	2.7	1.6	9.7	5.6	30	0.2	L.001	2.8	4.2	0.01	L.003	L.01	0.011	0.18
		01/03/89	-0.4	8.6	13.2	181	2.0	1.4	9.2	L.4	10	0.2	0.003	2.3	2.6	L.003	L.003	0.01	0.042	0.10
u/s Whitemud -l. centre	00AL07HA2810	17/05/88	9.0	8.3	10.1	199	2.8	0.7	16.4	928	70	1.2	0.001	5.8	6.8	0.72	0.010	0.02	0.075	2.08
		04/10/88	10.1	7.8	10.0	207	3.5	1.9	11.1	8.8	30	0.3	L.001	2.9	3.1	0.01	L.003	L.01	0.015	0.22
		01/03/89	-0.4	8.4	13.1	188	2.7	2.3	9.9	4.5	10	0.2	0.002	2.4	2.4	L.003	L.003	0.01	0.042	0.10
u/s Whitemud - centre	00AL07HA2820	17/05/88	9.1	8.1	10.1	201	3.0	1.0	16.6	916	70	1.4	0.001	6.3	6.8	0.78	0.012	0.02	0.155	1.88
		04/10/88	10.0	7.8	10.0	222	4.7	2.9	12.9	9.2	30	0.3	L.001	3.3	3.8	0.02	L.003	L.01	0.014	0.26
		01/03/89					3.4	3.3	10.9	172	20	0.3	0.001	2.5	2.6	0.14	L.003	0.01	0.043	0.28
u/s Whitemud -r. centre	00AL07HA2830	17/05/88	9.2	8.3	10.1	203	3.5	1.3	16.7	904	50	1.2	0.001	5.6	6.2	0.72	0.016	0.02	0.156	1.84
		04/10/88	7.9	7.9	10.0	228	5.2	3.9	14.1	10	30	0.3	L.001	2.8	3.1	0.01	L.003	L.01	0.017	0.26
		01/03/89	-0.4	8.2	13.0	200	4.0	3.8	11.3	L.4	20	0.3	0.002	2.6	2.6	L.003	L.003	0.01	0.045	0.12
u/s Whitemud - right	00AL07HA2840	17/05/88	9.5	8.2	10.0	206	3.8	1.7	17.0	704	80	1.4	0.002	5.0	5.8	0.72	0.012	0.02	0.067	1.64
		04/10/88	10.1	8.0	10.0	232	5.8	4.4	14.6	8	30	0.4	L.001	3.3	3.6	0.01	L.003	L.01	0.012	0.24
		01/03/89	-0.4	8.0	13.3	202	4.6	4.7	12.0	L.4	20	0.3	0.001	2.5	2.8	L.003	L.003	0.01	0.046	0.12
near Manning - left	00AL07HC1000	18/05/88	9.3	7.8	10.0	209	4.2	0.8	26.9	2610	70	1.6	0.003	9.6	10.4	1.18	0.025	0.03	0.083	4.20
		05/10/88	10.0	7.6	10.2	207	3.4	2.2	11.7	8.4	30	0.4	L.001	3.1	3.6	L.003	L.003	L.01	0.009	0.20
		01/03/89	0.0	8.6	13.1		2.3	2.1	9.3	145	10	0.3	0.001	2.4	2.5	0.119	L.003	0.01	0.046	0.24
near Manning -l. centre	00AL07HC1010	18/05/88	9.3	8.1	10.1	208	4.2	0.8	26.4	2764	70	1.6	0.003	10.8	12.5	1.18	0.022	0.02	0.081	4.20
		05/10/88	10.2	7.7	10.4	206	3.7	2.4	12.1	12	30	0.3	L.001	3.3	3.7	0.01	L.003	L.01	0.011	0.22
		01/03/89	-0.4	8.4	13.1	185	2.4	1.9	9.2	0.6	10	0.2	0.001	2.6	2.7	0.004	L.003	0.01	0.045	0.12
near Manning - centre	00AL07HC1020	18/05/88	9.3	7.9	10.2	208	4.3	0.9	25.8	2826	80	1.6	0.003	11.0	11.8	1.26	0.024	0.03	0.080	4.20
		05/10/88	10.1	7.8	10.3	213	3.9	2.5	12.1	11.2	30	0.4	L.001	3.5	3.6	0.01	0.007	L.01	0.009	0.20
		01/03/89	0.3	8.2	13.7	185	2.6	2.2	9.6	L.4	10	0.3	0.001	2.6	2.7	0.004	L.003	0.01	0.044	0.12
near Manning -r. centre	00AL07HC1030	18/05/88	9.3	7.9	10.2	208	4.2	1.0	25.0	2562	80	2.0	0.003	10.3	12.2	1.22	0.011	0.03	0.079	4.00
		05/10/88	10.0	7.9	10.2	217	4.1	2.8	12.6	10	30	0.3	L.001	3.6	3.8	0.02	L.003	0.01	0.011	0.26
		01/03/89	-0.3	8.3	13.0	195	3.2	2.9	10.4	3.6	10	0.3	0.001	2.6	2.6	0.006	L.003	0.01	0.045	0.14
near Manning - right	00AL07HC1040	18/05/88	9.4	8.0	10.2	208	4.3	1.2	24.7	2319	100	1.7	0.003	10.0	10.8	1.12	0.010	0.02	0.082	3.44
		05/10/88	9.8	7.9	10.1	220	4.4	3.1	13.2	8	30	0.3	0.001	3.9	4.2	0.01	0.003	L.01	0.008	0.22
		01/03/89	-0.3	8.1	13.4	199	3.9	3.5	11.2	2.6	10	0.3	0.002	2.5	2.7	0.007	L.003	0.01	0.047	0.12